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ESSAYS  
IN  
NATURAL HISTORY  
AND  
PHILOSOPHY.  
CONTAINING  
A Series of DISCOVERIES,  
By the Assistance of  
MICROSCOPES.

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By JOHN HILL, M. D.

Acad. Reg. Scient. Burdig. &c. Soc.

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U S S A Y

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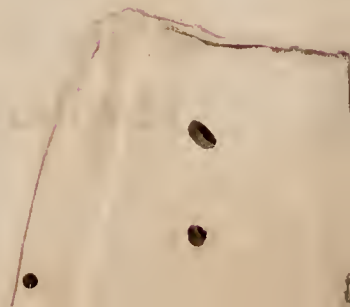
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U S S A Y

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T O

JOHN Earl of ORRERY,

Whose NAME is Praise,

T H E

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Proud to say that PAPER gave him such  
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ESSAYS  
IN  
NATURAL HISTORY  
AND  
PHILOSOPHY.

ESSAY I.

*On the Nature and Qualities of an Insect found  
on the Trunks of Fruit-Trees.*



HERE is not in the whole Circle of the Sciences any one which boasts so many Allurements as Natural History. There is not any that from the earliest Time has had more Votaries, or that is at the present so generally esteemed or followed. 'Tis a severe Thing to say after this, that there is not one which has been

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so

so little improved ; but 'tis not more severe than true. If we look into the Writings of *Theophrastus*, and the rest of the earliest Authors among the *Greeks*, we shall find an amazing Fund of real Knowledge: an Acquaintance with natural Bodies, that shames the present Ignorance: And to set the Account in its true Light, it does not appear that the Improvements and Discoveries which have been made in it to this Time, compensate the Loss of all that Science, which seems to have been familiar in theirs, but with which, as they have not particularized it, we have now no Acquaintance.

It must be owned, that the Knowledge these venerable Fathers of Natural History had of the Surfaces of Bodies was less than ours; but they knew much of their Qualities, which it would be a Happiness to the World if we could restore. Our Books contain an Enumeration of more Things by a surprizing Number than theirs; but of the few which they made the Subjects of their Researches, the Uses were known. That was indeed the Intent of all their Investigations: Natural History was but the Hand-maid of the more useful Sciences; nor was it supposed so much Honour to a Man to have discovered twenty before unknown, or unobserved Plants, as to have found a new Virtue in Medicine, or new Use in some of the Arts of Life, in a before well known one.

Our Naturalists are more of the Turn of those Geniuses, who will not descend to meddle with any Thing that can possibly be made of Use to the World; who study Science for its own Charms,

Charms, and would think themselves degraded by a Character of having furnished Mankind with any Thing that was of Service. Science to these, like Virtue to the Good, is esteemed its own Reward; and it would be reckoned an Insult upon its Dignity, to make it stoop to accept any other. If we would astonish our Eyes with the Numbers of Objects of the visible Creation, we must look into the present Writers; if we would know the Uses of them, we must inquire after them in the less enlightened Times.

I would not be understood by this, to ridicule the bare Science of Natural Knowledge. Naked and useless to the World as it is, Men are to be applauded for prosecuting it; nor is it an unequal Task for a whole Life, to study the Forms and Outfides only of Things. While some however are thus employed in distinguishing the Characters of Bodies, let others apply themselves to the Uses: While our Naturalists are mere Philosophers, let our Physicians be Searchers into the Uses of what they discover. When I oppose the Knowledge of the Antients, to that of the present Period, I am aware of its Deficiencies; and this which I have pointed out is the Remedy. The Writers of the past Ages were so industrious in the Prosecution of the useful Part of the Science, that they neglected the curious. While they were indefatigable in their Inquiry after the Virtues of things, they forgot their Forms; and in Consequence, tho' they have left us Accounts of Plants and Animals, which their own Experience had found to be Remedies for Diseases that baffle all our Attempts, we have no

Advantage from their Discoveries, because we are not able to ascertain what they mean by their Names of Things, from the Deficiency in their Descriptions of them.

Fond as I am of Natural History, I see it only the Servant of the useful Arts, as of Medicine and the rest; and the false Taste of which I would now accuse the World, is the pursuing the one, independently of the other. Each is the Business of a Life: The Requisites for them are different: Let them be then the Province of several People: We have at this Time arrived at such a Degree of Accuracy and Precision in determining the Characters of Bodies, that while our Works remain, there can be no Doubt about what is meant by any Name; let us see those who will with as much Application discover the Qualities that belong to each, and we shall then, nor can I be brought to conceive, that till then we can, rival the Antients on these Subjects.

'Till Men had this Ascertainment of the natural Properties and Species of Things, it must have been impossible to carry the useful Parts of the Sciences to any Degree of Perfection: And tho' every Attempt in it were laudable, every single Discovery useful, yet the Uncertainty behind would deter People from the Prosecution. How late this Truth and real Distinction have come among us, will be evident from a Review of the Productions of the Men of Genius of the last twenty or thirty Years, compared with those of all who went before them. We find in the Writings of the most celebrated, of but the last Century, not only Mistakes of one Body of  
the



the same Family for another, but Confusions of the Subjects and Qualities of the three distinct Kingdoms: We see animal Substances confounded with the Vegetables and Minerals; and even Gold itself raised into the Property of a Plant, and described as growing in Shrubs among Corn. 'Tis an invidious Office to point out the Authors of Absurdities like these, but there are few at all acquainted with the Science, who will not recollect them on the Mention. It is but till within a very few Years, that our Cochineal, a Drug in common Use for a long Time, was known to be an Animal. The received Opinion of the World was, that it was the Seed of a Plant: Our Kermes, another useful and precious Insect, was supposed to be an Excrecence of the Tree on whose Juices it feeds; and still later than all this, the Polype, even while it moved, and felt, and eat before us, was by many declared a Vegetable. The Insects that feed on the Juices of our Orange-Trees were taken to be Scales upon their Leaves; and a whole Class of Animals, one of which is the immediate and particular Subject of this Essay, were universally called Warts and Foulnesses of Trees and Plants.

The Microscope has led to the Discovery of many of our greatest Improvements, nor are we to reproach the Naturalists of old Time with the Ignorance of these, so much as those whose Studies led to the devising those Instruments of Information; and notwithstanding all the Warmth with which I have been pleading for the Combination of the useful with the entertaining in these Studies, it will appear from this in particular, as well as from the

Course of the whole Body of the succeeding Essays, that I have Eyes open to all the Pleasures, all the Advantages of the merely speculative Part of the Science. The Microscope of which I am so fond, and the Discoveries of which will furnish so large a Part of this Work, serves but very rarely to the Discovery of Qualities in Bodies: Its Object is their Forms, but whilst it ascertains these, it is the Assistant of useful Knowledge, and while it leads to a Discovery of a thousand Wonders in the Works of his Hand who created ourselves, as well as the Objects of our Admiration, it at once improves the Faculties, and exalts our Comprehension. It gives a thousand new Sources of Praise to him to whom all we pay is nothing in compare with what we owe; and while it pleases the Imagination with the unbounded Treasures it offers to the View, renders the whole Life one continued act of Adoration.

This, if we descend to the Particulars of the present small Addition to the Stores of Natural Knowledge, is all it has to claim; but a Mind conscious of the Benefits that may accrue from the whole of a Science, and eager in its true Glory, could not step into the most distant Tract of its Territories, without a Sense of the Magnificence of the whole.

Beside the Kermes, and the Insect of our Greenhouse Plants, both which pass the greater Part of their Lives in a State of Rest and close Application to the Tree or Plant, whose Juices support them, there are a Multitude of others, which from the same Accident, have shared the same Fate of  
being

being mistaken for Parts or Excrescences of the Trees on which they are found. One of these is the immediate Subject of the present Essay. It is of the same Class with a whole Series of those described by *Sedileau, De la Hire, Reaumur*, and others of the *French*; for the Naturalists of our own Nation have been hitherto silent about them, but it is a Species wholly different from all that these Authors have been acquainted with.

It is now about six Years since, walking in *American Grove* at *Goodwood*, with the ever to be honoured and ever to be lamented Master of that Paradise, I observed the whole Trunk of a young Tulip-Tree, of the same Species with that which has so often flowered with us at *Fulham*, covered with little Protuberances in Form of common Scales or elevated Pustules, covered with a wrinkled Skin. The Gardener who was ordered to say what he knew of them, called them Scales and Foulnesses of the Bark; and on my questioning him how long they had been there, and what he had at any Time observed of them? he answered that they came every Year in Spring, and mouldered away about Michaelmas, and that he had always found they were a Proof of the Tree being sickly.

The Observations of the *French* Writers on the Insects of this Class, immediately gave me an Opinion that these were Animals. I mentioned the Opinion to his Grace, and with great Facility separated several of them entire; and that we might be in a Condition of examining them in every Situation, took off a thin Piece of the Bark from a Part of the Trunk where it was most crowded, with a confi-

derable Number upon it. The Gardiner, tho' none of the most illiterate Rank, after he had carefully viewed those which were loose in my Hand, shook his Head at my taking Scales to be living Creatures. The Duke was earnest in the Inquiry, and as he was always furnished with microscopical Apparatus's of all Kinds, we were soon in a Condition to prosecute our Investigations.

I first adapted a single Magnifier of small Power, with the proper Apparatus for examining opake Objects, to a Piece of the Bark which I had cut from the rest, just to a Size to be taken in by the Area of the Glass, and with one of the Objects upon it. The Appearance tho' singular was far from carrying Conviction of what I had suspected; there was seen a small Protuberance on an even Part of the Rind, fixed down to it at all its Edges, as firmly as if growing from it, and giving no Sign of Animal Life, or the least Notice of its ever having occupied any other Place, than that in which it now stood. Its Form was triangular, with three sharp Corners, and an elevated Ridge on the Back; all that could farther be discovered of it was, that it was composed of a membranous Substance, strengthened round the Edges, and along the Ridge of the Back by a Kind of Rim which was rounded, and more solid and thick, than the rest, and that its whole Surface beside was formed of a Kind of Scales falling over one another in the Manner of the Tiles on a House, having their Bases toward one of the Sides of the Triangle, and their loose Edges turned toward the opposite Point; these were larger toward the broad End, and gradually diminish-

diminished toward the other, and were properly not singly extended across the whole Figure, but arranged in two Series, one covering each Side; or at least their Continuation was obliterated in the Middle at the Ridge. Toward the sharp End there was a small longitudinal Fissure in the Centre of the Rib of the Back; this had at first seemed accidental to the particular Individual under Consideration, but on Examination we found it exactly in the same Place in all.

Hitherto there had appeared no Notice of the Object being an Animal. The common Excrescencies on the Oak, have as particular and as regular Forms. I no sooner however had raised it with the Point of a Needle from its Situation on the Bark, than the same Apparatus when directed to the under Part of its Body discovered it to be an Animal, tho' an undescribed, and wholly unknown one. We could now discover at the first View six Legs, and one of them which I had wounded with the Needle was in Motion. The Rim which we had observed surrounding the Body, and had supposed to be round, we perceived was flat on that Part where it was applied to the Bark, and had been fixed down to it, by an innumerable Series of those Fibres, arising from its Edges principally, but in some Degree, from every Part of its Surface. Between this Verge or Rim, and the Sides of the Body of the Animal, there appeared at first View to be a vacant Space, and the outer Husk or Shell had therefore the Appearance of an artificial Covering formed by the Creature, rather than any real Part of its Body. The Application

of a more powerful Magnifyer, however, soon shewed his Opinion to have been erroneous; and we found the Skin of the Belly to be continued to meet that of the Back at the very Edge, tho' it was only in the Middle that it was distended so as to shew the Lineaments of a Body.

In this View it was plain that the whole was a simple Insect. What appeared on the outer Surface, was the genuine Covering of its Back, and what we now saw, that of its Belly; and these meeting at the Verge, formed by their Duplicatures a Kind of Band for the strengthening, and the better fastening down the Creature to the Bark of the Tree. By the Assistance of this larger Magnifyer, we were enabled also to discover its whole Form, its Parts and Organs. I have observed that the Rim was fastened down by a great Quantity of fine Filaments: The whole under Surface of the Body we now had an Opportunity of seeing, was covered with the same Matter, the several Fibres of which being close and in continued Clusters, formed a soft Covering to it; and on examining the Part of the Bark from whence I had raised the Creature, we found a great Quantity of the same fine Down left on the Place, and forming a Kind of Bed for to lie at rest upon. What a Provision of the Author of Nature was here! for what may at first Sight appear so despicable, so miserable an Animal. What Misery should we suppose it on a first Consideration, for it to be fixed down without any Power of exerting the great Privilege of Life Motion, to continue in one Spot, exposed to Injuries of a thousand Kinds, and incapable either of

Defence or Escape. But let us examine the Matter more deeply, and we shall have Reason perhaps to account the Creature one of the best, instead of one of the worst provided of the Creation, even in this its fixed State. Its external Form is so like that of a Part of the Tree on which it is supported, and carries so little of the Appearance of any thing animal, that it is better guarded against the thousand Destroyers of the Insect Kind by its Obscurity, than it could be by Legs or even Wings; and escapes by Millions at a Time, while all these Instruments of Flight cannot preserve so much as one in a hundred of others of its Size. That it is fixed to one Spot is hardly a Pain to it, while that Spot affords it all the Indulgencies for which it has probably Sensations. The Tree affords its Juices for ever new and abundant for its Support; the hard Covering of the Back keeps off trivial Hurts, and under the close and impenetrable Covert of this it lies stretched at its Repose in Warmth and Security, on a Bed of the finest Down. Ease and Plenty of Food seem all that most of the Brute Creation require, except the Indulgence in the Propagation of the Species, which is not denied this Insect; and these it evidently enjoys in a Degree almost beyond them all.

It was necessary to blow away and separate with the Point of a fine Pencil some of the Down from the under Part of the Body, in order to obtain a Sight of its several Parts; but no sooner was this done, which is easy with the Assistance of a fine Pencil and a small Magnifier, then we distinguished every Part of the Insect's Form. The Head appeared

peared at a little Distance within the extreme Verge of the Shell, round and prominent. On each Side there is a small black Speck or Eye. In the Midst between these is the Organ of feeding; but this is not a Mouth, as in the Generality of Creatures, but a long Proteoscis or Trunk, sharp at its Point, and formed for striking into the Tree, to get at its Juices. Behind the Base of this stood two short and fine Antennæ, much like the Horns of some of the Beetle-kind; they are each formed of thirteen oblong and rounded Joints, and have the Appearance of a Necklace or String of Beads; the extreme Joint is smaller than the others, and pointed at the End.

The Division of the Breast from the Body was very evident; the Breast was nearly smooth on the Surface, and the Belly marked with about seven scaly Rings, with deep Incisures between them: The whole Body was of a kind of conic Figure; and at its smaller Point, near the extrem Verge of the Shell, there appeared an Opening considerably large in Proportion to the Bulk of the Animal. Beside this, we very evidently discerned the Joints and the scaly Armature of the six Legs, which were placed just as in the Generality of Insects, and each was serrated in the upper Joint, and terminated in a bifurcated Claw. We were not able to distinguish any Motion in any Part of the Animal beside the hurt Leg, except in the Trunk; but this it moved about in many different Directions, as if in Distress for Food.

When we had thus satisfied ourselves of the Form of the Creature, and its Way of feeding, it remained



remained to examine, if possible, into its Manner of Propagation. Of the several that I afterwards dislodged from other Pieces of the Bark, some were lame, some less distended in the Belly; and in all those that were most distended, we saw the Opening at the Tail larger. It was easy to conceive that the Distension of the Body was owing to Eggs, and that this was the Aperture at which they were to be discharged. We succeeded so well in the Attempt to discover this, that we forced out from several considerable Numbers of them. They were of an oval Figure, very minute, of a pale Colour, and connected by a viscous Matter, which came out with them on the pressing, and formed them into long Series, in the Manner of Eggs of Birds, as we see them strung on Threads by Children.

Thus much was made out by a microscopical Examination but there remained yet a vast deal to be enquired into, in regard to the Nature and Oeconomy of an Animal so singular in its Manner of living. The inquisitive Mind could not rest with thus much Knowledge of a Subject over which there yet hung so much Obscurity. The Power of Glassés could do no more; the rest remained for a Work of Time, and repeated Observation of the Creature at its different Periods. All those which we had examined had been without one Exception Females; we had squeezed Eggs in great Number out of all that we pressed. The Gardener had observed, that in Autumn they all fell off from the Tree, and the Question was what then became of them.

The Period of Life at which our Observation of these Animals had begun, was that of their being full of Eggs, not yet arrived at a State of Maturity for Exclusion. We continued the Observation and Examination with fresh ones taken from different Parts of the Tree every Day or two, for several Weeks: We saw their Bodies more and more distended, we saw them at length filling almost the whole Cavity of the Shell, and soon after this we saw the Eggs begin to be laid.

It was Matter of great Surprize to us to find that in this particular the Insect differed from all the other Creatures in the World; for as they discharge their Eggs and leave them at a Distance from their Bodies to be covered by them again, in Order to the hatching only at their Pleasure, Nature in this had provided for the motionless State of the Animal, by keeping them all the Time under it. The Eggs as they were protruded out at the Opening behind, were not forced from under the Shell, but were kept within its Confines, and disposed in a very regular Manner under the Body of the Animal. The Space that was again made under the late full Shell, was from Time to Time filled by the Eggs laid in it, and by Degrees the whole Number, which is immense and incredible from each Insect, were laid in the Cavity, their Heap still pressing the Belly more and more upwards, till at Length when they were all laid, we found the Skin of the Belly pressed up close in all Parts to the Back. The Creature who had now answered all the Purposes of its Creation was dead, and its whole Body formed only a  
dry

dry Shell or Covering for the Eggs, from which a new Brood were to be hatched.

This was the State of the Creature toward the End of *August*; in *September* as the Gardener had said, they all fell off of themselves; and we found that before this happened, the Eggs had all been hatched. The Process is this. After the Eggs have been a necessary Time under the Covert of the Case or Shell, formed of the whole Skin of the Parent Animal, the Back and Belly being united in it, they hatch into Young, perfectly like the Parent, and extremely minute: These soon find the Way to gnaw a Passage from under the Shell, and as this is done in several Places at once by the immense Numbers of the Brood, the whole Fastning by Degrees is eaten away; and the Shell falls of itself.

This was an Incident the Gardener had been acquainted with from Year to Year, tho' wholly ignorant of the Causes of it, nor at all suspicious, that the Rudiments of a new Parcel of the Scabs, as he called them, were then living on the Tree. The little Creatures we examined from Time to Time. They were always to be found in Numbers on any Part of the Bark, or even after a few Days, of the Leaves; for they soon crawled thither, and the whole Expanse of the Tree was covered with them. We were frequently entertained also with the Sight of a very singular Kind of oblong and annulated Worm that played about among them, but seemed not to attempt to do them any Injury; this Worm was larger considerably than they; its Body blue, its Head of a shining

shining Black, and the several Rings of its Body ferrated as it were with Spines. This was as much an unknown Insect as the other, and it appeared singular to us, that we never saw it on any Tree or Plant, except this Tulip-Tree, nor on any Parts of that, at the Times when the Whole was not yet covered, except where these other Creatures also were.

My Affairs called me to Town in *October*, and his Grace, whose Love for natural Knowledge was as great as any Man's I have known, was not long in the Country after. The Care of observing the Progress of this numerous Family was left in proper Hands, and the Result was, that it appeared by continued Observation, that the Creatures kept running about upon the Tree the whole Winter, and in all that Period very little increased in Size, but that in Spring they all at once fixed themselves on the Bark, and from that Time began to grow bigger. That in about six Weeks they came to their full Size, and from that Time remained motionless. The ripening of the Eggs going on as we had observed it, till at length the Parent perished, and the Shell formed of the Remains of its Body falling off, the new Progeny appeared.

As all these Creatures were palpably Females, all producing Eggs in the same Manner, there still appeared something unaccountable in the Impregnation and the Propagation of the Species. All the Attempts made to understand this at *Goodwood* were vain; it happened, that the Observation was made during the last Visit I had ever  
Oppor-

Opportunity to pay there. I had wished in vain for more Means of inquiring into this Wonder, when after about five Years, so slow are the Advances in these Studies, I saw in the Gardens of Lord *Burlington* at *Chiswick* a Number of the same Animals on the Bark of the Trunk and Branches of a Tree of the same Species on which I had first observed them. I took home a large Parcel of them in a Box for Examination, but it was not till I looked upon them there, that I found I had also brought with them several Specimens of a small Fly, of a Kind wholly unknown to me. It is not running from the Subject, to take this Opportunity of describing the Insect, no Figure or Description of which is any where extant, and with which all the Naturalists of the World seem to have been as perfectly unacquainted, as with the Creature which was the accidental Occasion of my observing it. It was one of the the smallest Flies I have ever seen; had it been much less, the naked Eye would not have been able to distinguish any Thing of its Parts. As it is, that is to be done but very imperfectly without a Microscope. When placed before the Apparatus for examining of opaque Objects it makes a very beautiful Appearance. Its Head is large, its Eyes are very conspicuous and bright, its Shoulders are large, its Body is of an oblong Form and terminates in a Point, having something the Appearance of a Sting. Its Wings are only two, but they are so long that they cover the whole Body, and they are not transparent as in the Generality of Flies, but opaque and beautifully coloured, as in the Butter-

fly Kinds. On the Head there stand a Pair of Antennæ or Horns, very slender, but equal to the Body in Length; and from the Sides of the Body, near the Tail, there grow two Hairs, from each Side one; these are nearly twice as long as the Body, and are so very slender, that the naked Eye does not at all distinguish them.

The Body of this little Creature is of a silvery white, the Legs also are white, and the Wings are of a pearly Colour, variegated in an elegant Manner with Spots of yellow and brown.

When I had spread out my Number of the larger Insects, I found a considerable Share of these little Flies among them; they seemed fond of being about them, and tho' their Wings were long enough to support them in the Air with great Ease, I never once saw them, in the Course of the whole three Days they lived with me, attempt to rise. They walked about on the Bodies of the other Insects, and at Times remained fixed for some Moments on their hinder Part. The Business here was soon discovered; the Point at the Extremity of the Body of the Fly contained its Organs of Generation; this was in all these stationary Moments thrust into the Fissure or Aperture, which I have already observed there is in the Back of every one of the other Creatures; and it appeared sufficiently evident from this, that the winged Insect tho' so strangely disproportionate in Size, was in reality the Male of the same Species of which the larger and fixed Creature was the Female. Here therefore was all the Mystery of the Generation of these little Creatures

tures explained ; and I have found by Observations since made, that these Flies are produced out of Eggs of the same Brood with the other Insects ; that the first Appearance of both is the same, and that it is only when the Females become fixed down on the Bark, that the Difference is seen.

As soon as those which are to produce the male Fly are arrived at their due Growth, which is not nearly that of the others, instead of a Number of Eggs an Aurelia is produced, like that of other Flies, and from this the Fly soon after appears, making its Way from under the Shell, in its full Size and Proportion. It is no sooner at Liberty than it impregnates the Females all about it ; and as it has in this new State no Organ for eating, its sole Business of Life being the Propagation of the Species, it then dies. The Females after this continue in their Places, discharge their Eggs, and die ; and from the Brood of every Individual there are produced a great Multitude of Females and a few Males, which are by no means to be distinguished till the Period at which the Male assumes its Fly-State.

The blue Worms, mentioned occasionally in this Essay, as always found among these Insects, are produced from Eggs laid in the very Bodies of these Females, by a Fly of a very different Genus, one of the Ichneumon Kind ; and after a proper Change they assume the Form of their Parents. They feed on the Juices extravasated by the Punctures of these Insects, but do them no Harm, nor is the Female hurt by fostering them in her Body.

## E S S A Y II.

*On the Structure, Accretion, and Fruëtification of a peculiar Species of Coralline, and occasionally of the Fruëtifications of some other Plants.*

A Few Days of Leisure, and an Intimacy with a very worthy and ingenious Man, near the Island of *Sheppey*, carried me last Summer to visit the Coasts of that little Spot, and the Seas a few Leagues Distance from it. We hired a Vessel, provided every thing that was necessary for the taking up and preserving what Objects might occur worthy the Attention of the Naturalist, and spent a very agreeable Day, the greater Part of it not out of the Sight of Land, but at a considerable Distance from it. Our Attendants were provided with an Instrument made for the taking up Oysters from the Bottom, and there was never an Occasion of letting down this, on which it did not bring us up an amazing Variety of both the animal and vegetable Inhabitants of the Deep.

The Shells of our common Oysters are frequently covered with both the one and the other of these Profusions of the Beneficence of the Creator; but the Man who would have the proper Opportunities of enquiring into their Structure, Formation and Qualities, is not to examine them in this imperfect State, in which they have been injured by Accidents in the Carriage; and are out of Vigour,  
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from the mere Circumstance of being kept out of their proper Element. In this Expedition we were at great Pains to select the most perfect Specimens of every kind, and to preserve them, from the Instant of their being taken out of the Sea, in their own Element, and in Vessels of such a Form, that it was not easy for them to suffer Injuries. The Species I brought to *London*, in this single Excursion, were no less than sixty of the animal, and one hundred and twelve of the vegetable kingdom.

With what amazing Numbers has the Beneficence of the Creator, unlimited as his other Attributes, peopled and planted the Bottom of the Deep, where no human Eye looks into the Wonders of his Goodness, where no rational Creature, no Heart capable of praising him for his Works, has an Acquaintance with them! Know we from this, that altho' we may suffer Pride to persuade us that all Things are made for our Purposes and Pleasure, Reason contradicts it. We are only one Species of Being, formed by the Hand that has made Millions of others, and owing our Existence to that Beneficence, which, while its attendant Attribute, Wisdom, so ordered every Thing, that it should be subservient to the Purposes of others; yet has made one great End of all Creation, the Creature's Pleasure in its own Existence.

In the Numbers that occurred in this Research, and had been brought up to Town in Safety, more than one or two have furnished Matter for these Essays. The far greater Part perished by Degrees, almost unobserved, during the Examination of the

others ; but even those had not been brought without answering this Purpose, that the Remembrance of them lived in my Mind, and I knew where to send for them again.

Among the first and most conspicuous Objects that offered of the vegetable Tribe, was a Coraline, a Sea Plant of singular Beauty, and in a State of very uncommon Perfection.

The Plants which Naturalists have distinguished by this Name, are all of them elegant and singular in their Structure ; they have neither Roots nor Leaves, but consist of Trunks and Branches, elegantly divided and indented, or otherwise unequal on the Surface. Some of them are composed of Joints, fastened to the Extremities of one another, in the Manner of the Beads of a Necklace ; others of distinct Joints also, but of a peculiar Kind, formed largest at one End and fixed into each other ; and others, of which are the larger Number, are of a continuous Substance, but indented deeply in the Manner of the Edge of a Saw, along each Side both of the Trunks and Branches. In these some have the Denticulations of the two Sides distinctly opposite to one another, and by this Means carry a Resemblance of the Structure of the jointed ones, that might deceive an unwary Eye ; and others have them placed alternately, in such Manner that the Plant seems, where they are of the deeper Kind, in Danger of breaking at every new one.

Of the Plants thus entitled to the Name of Coralline, some are of a gritty or stoney Texture, approaching to the Nature of the Corals : From these  
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the whole Genus has probably derived its Name, but the greater Part of them are of a softer Matter, flexible, tough, and more or less transparent.

This Explication of the botanical Term, may serve to give every Body, however unacquainted with the Science, a distinct Idea of what is meant by the Corallines in general. The particular Plant which affords the Subject for this Essay, is one of the most singular and beautiful of the whole Race: Scarce any exceeds it in Size, not one in Elegance. The Authors who have studied Plants, cannot but have met with it, tho' perhaps in an imperfect State, as it rarely appears in the Beauty in which the singular Specimen to be treated of in this Essay shews it; and to this it is probably owing that there is not a good, nor even a tolerable Description of it extant. Some of the late Writers have collected among their Names of Species, one that seems to have been intended for it, but a Description has been wanting; nor was I in a Condition to give one when I publish'd my *History of Plants*, having then only seen the imperfect Pieces of it, that are sometimes found on our Oyster-shells. It is there enumerated only among the several Species, under the Name of the *Broad denticulated Coralline*.

A little round Pebble served for its Place of Growth. On this there was extended a thin Plate, of a brown semi-transparent Substance, of a rough Surface, and of the Breadth of a silver Penny. From the Center of this expanded Base (for the Sea-Plants have no Roots) arose a single Stem or Trunk, ornamented with Branches from about the

Middle upwards, and at its Top, divided into two Parts. The whole Plant was nine Inches and a half high; the longest of the Branches never more than four Inches in Length: Not one of these was divided at the Top, but all simple and obtuse at the Extremity; they stood irregularly, not in Pairs, and their Direction, while the Plant was in its Vigour, was not horizontal, but they rose almost parallel with the main Stem, and were nowhere an Inch distant from it.

The whole Plant was of one clear transparent uniform Substance, of the Colour of dusky Amber, a fine Brown, with a Tinge of Yellow. The Whole, from the Top of the Branches to the Base of the Trunk so transparent, that Objects placed behind, might be seen through it; and of a natural Polish, equal to that which Art gives to the wrought Genus. All this Beauty, however, is only to be found while it is in Vigour, and in its natural Element; nor should I wonder that People who see broken Pieces of it in a decaying State, should find it difficult to know it by the Description. The Sea-Fishes, many of them, have a Height of Colouring that astonishes while they are just taken up and yet living, which almost entirely goes off as they die; nor is this Change between Health and Decay peculiar to the animal Inhabitants of the watry World: This, and a thousand other Plants, shew it in as eminent a Degree, tho' the Observation occurs more rarely. The polished Surface of this Plant is lost in the decaying: Its Transparency is at an end when taken out of the Water; and when it has been long on the Shores,

as is usually the Case with the Specimens that are found, it becomes White, and perfectly opake.

The Stem and Branches of this elegant Plant are perfectly of the same Shape and Structure, as well as Colour: They are not round, but compressed, and of a Breadth at least three times equal to their Thickness: They are very deeply denticulated, and the Denticulations are placed not opposite to one another, but in an alternate Order. Each of these is cut to the Depth of nearly half the Diameter of the Stem, and consequently the Body of the Shoot, or even of the Trunk itself, seems but ill able to support the Height and the Burden of the Branches. This Observation is indeed so far just, that in the Air the Plant does not support itself erect; but in the denser Medium, in which it is found to grow, it keeps perfectly erect.

It has been observed of some of the Species of Coralline, that they have a kind of oval hollow Bodies standing in the Alæ, or arising from the Base of some of the deeper Denticulations. These have been guessed by many to be the Air-Bladders, serving to support the Plant from sinking, as it has been discovered that they are hollow: But this is an Error, owing only to want of continued Observation. These hollow Bodies do not continue all the Year on the Plants which are known to have them; and many not supposed to be furnished with them, owe the Opinion of that Deficiency, only to their having been observed at a wrong Season. These Vesicles are only three or four Months of the Year on the Plants; and this elegant

elegant Species, tho' Authors have not known it, is one that has them. The Specimen which I was at this Time so happy to meet with had more than Seventy on it, and the Remains of others of succeeding Years might be discovered on other Parts of its Branches. Thus much the naked Eye could discover in the Plant, kept in a Glass of filtrated Sea-water; and to that imperfect or rather limited Organ, it afforded a Spectacle of so much Beauty, that many People who knew nothing of Botany, nor had any particular Object to which to direct their Scrutiny, have spent several Minutes in admiring it.

But if it could surprize on so imperfect an Examination, what must have been the Pleasure of the Naturalist, warm in the Investigation of the Works of his Creator, and eager in the Pursuit of Knowledge in the Science, to have accompanied me in the Examination by the Microscope; in the enquiring into the Form of its several Parts magnified to many thousand times their natural Bigness, and disclosing Wonders, scarce guessed at by the first Men in the Science, never at all understood by any!

The first Discovery made by this Apparatus was, that every Part of the Plant was hollow, each Denticulation formed an oblong Cavity, largest in the Middle, and closed at each End, at the Top of the Denticulation by its Point, and at the Base by a transverse Membrane. This kept the whole Plant from being one long Tube, or continued Hollow; and divided every Branch of it into a vast Number of distinct and separate Cells.

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The Vesicles or hollow Oval Bodies, which stood in the Alæ of some of the Denticulations, were discovered to be perfectly close on all Parts, obtuse at their Ends, and of a smooth Surface, but with the Appearance of a spiral Line drawn within them, and making several Volutions on their inner Surface. In many of the other Denticulations there were discovered the Rudiments of future Vesicles, or the Remains of decayed ones; and in the Center of every Denticle, where that was not covered by such a Vesicle, it was easy to discover a little Aperture, communicating with the Cavity within.

Thus much the Plant afforded to the curious Eye, as seen whole in its Element, with the Assistance of a Magnifier, whose Focus was not so near, but that it could be applied on the Outside of the Glass in which it was kept: It was easy to conceive that the Vesicles might have a more important Use, than that assigned to them by those who had hitherto offered their Conjectures on the Subject; and I determined the trying the utmost Effects of the Microscope, to discover their true Nature. To this has been owing the Discovery of the Fructification of the Corallines, till this Experiment, one of the Desiderata in Botany: A Thing so far indeed from having been understood, that the *French* Naturalists of this Time, and among them the eminent and ingenious *Jussieu*, have determined the whole Race of them to be no Plants at all; but from their finding Animals lodged in several Parts of them have declared the Bodies themselves to be only Cases made by such Insects for their Habitation. This is an Error of the first Magnitude in Natural  
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Philosophy, and it has strangely gained Ground. The World is fond of every thing that has the Recommendation of Novelty, and has but a Pretence to Reason. The *French* have in general received the System; and *Linnaeus*, ashamed of the Ignorance hid under his Arrangement of the Cryptogamia, has adopted it, and at one Stroke wiped off more than five hundred from the Number of Plants, whose Fructification he did not understand. Strange that Men used to Investigations of the natural Productions, should not see that all that Apparatus visible in many of the Sea Plants could not be necessary to the Habitation of an Animal! But 'tis happy that Observation can now absolutely put a Stop to the Progress of so unbounded a Mischief; the next Effects of which, would probably have been the proving many of the Land Plants, whose Fructifications are less distinguishable, to be also Cases formed by Animals which chance to be found living in them; and perhaps Men might at length have arrived at proving the Fungus's the Fabricature of Snails and Beetles, which find in them at once Shelter and Food.

Determined on discovering the Structure at least of the Vesicles on this Vegetable, I separated one with the Point of a Lancet from the Plant. I don't pretend that the first Attempt succeeded, but after some Endeavours I got off one entire. On bringing this before a single Magnifier, which from its natural Dimensions, about equal to those of the Head of a small Pin, magnified it to the Size of a Nutmeg. I could discover that it was a kind of Bladder, formed



of a Membrane, not extremely thin, yet transparent; and that tho' hollow it was not perfectly empty. Its Surface was smooth and glossy, covered with an unctuous Fluid, and of a whitish Colour: Its Figure elliptick, or what we express somewhat improperly by the Term Oval, obtuse and equally large at each End: No Aperture was visible in any Part of it but thro' the transparent Sides. It was now easy to see that the spiral Line before distinguished, began at the very Summit of the Vesicle, and terminated at about two thirds of its Depth. From this Termination of the Line, there was a little vacant and unoccupied Space; but from the Verge of this, to the very Base of the Vesicle, there were again drawn not one spiral Line, but several detached circular ones.

Thus much was discovered while the Body was whole. On cutting open a Number of them, and employing the double as well as single Microscope, examining them in all Lights, and all Directions, in Portions of different Bigness, and in their Element as well as dry, the whole Fructification of the Plant was perfectly discovered; and these Vesicles were found to contain all the Organs of it.

The Fructification of all Plants, from the Cedar to the Moss, or as our Translators have chose to express it, the Hyssop of the Wall, is performed by different Organs, some of them containing the Rudiments of the Fruit, in the Manner of an Uterus, some the fecundating Matter, which is in all a light and extremely subtils Powder held in Vesicles,  
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called Antheræ. These last, are from their Office called the male, and the former from theirs the female Parts of the Flower. It is from the larger, and, as they are much at random called, the more perfect Plants, that we can be able to judge of these Parts in the more minute ones. In most of the larger Plants the male and the female Parts are contained in the same Flower, in others they are kept distinct, and grow on different Parts of the same Plant; as is the Case of the Alder, the Birch, and many other of the Trees, and in all the Melon and Cucumber kind: In the latter of these the separate Flowers which contain either of the Parts of Fructification, are in their other Parts entire; in the former it is not so; and in many of the lesser Plants, the mere Organs of Fructification are all that are allowed, and there is nothing of the Apparatus of the Cup or the coloured Leaves of the Flower.

The Sea Plant under our present Consideration is of this last Kind. Nature has allotted it distinct male and female Parts of Fructification: They are placed, not together, but in separate Ranges, at a Distance from one another; and they have nothing of the Apparatus of a Cup or coloured Leaves to each, but are simple and naked: They are sufficiently preserved from Injuries, and kept to their Maturity, in the Vesicle which forms the general Covering for them all.

The spiral Line on the Inside of this Vesicle, occupying two thirds, or nearly so much of its Cavity, is the Place of the Adherence of the male Flowers, and the circular Lines toward the Base contain

contain the female. The Space between these several Lines separates them sufficiently from one another, but if it did not, their Forms would not fail to distinguish them. On cutting off a Segment of the Vesicle, with the upper Part entire, I discovered that there was not, as I had supposed, a spiral Line marked with a Ridge or Hollow on the Surface of the Vesicle, but at the very Summit there stood a minute Pedicle, supporting three extremely small oval Bodies, fixed without separate Peduncles to its Summit. This was the beginning Point for a Series of others of the same Form which succeeded it, and were placed after one another in the Form of a Spiral continued thro' several Volutions. They stood very close to one another, and the continued Series could not but discover itself from without, in Figure of a Line drawn in that Form. Each of these Bodies is in itself a separate male Flower. There is no Cup, no coloured Leaves, on any other Part of the usual Apparatus, but the Pedicle which answers to the Stamen or Filament in the Centre of a common Flower, grows immediately from the naked Membrane that forms the Capsule, and supports on its Top three Antheræ. These are the oval Bodies before mentioned; they are very minute, their Length scarce equalling half the Diameter of the Pedicle or Stamen which supports them, and they hang so loosely that they are in almost continual Motion.

The female Flowers, which are the Bodies that occupy the lower Part of the Capsule, and form the circular Lines there, are almost as simple in their Structure as the male ones. There are no elevated

elevated or depressed Lines in this Part, any more than there is a spiral one on the upper; but the female Flowers standing close to one another in a circular Series, form the Appearance of such Lines, as the male ones in their Disposition do that of a spiral. There is to these Flowers no Corolla or Ornament of coloured Leaves, nor is there any other Part of the Apparatus of a Flower, except the Rudiment of a Fruit and a Receptacle for it.

On repeated Observation it appears, that there are in this Part of the Vesicle a Number of little Cavities placed together so as to form several concentric Circles, and each of these Cavities performs the Office of a female Flower, serving as a Receptacle for the Fruit of the Plant. Each Cavity is of the same exact Figure and Dimension; they are very shallow, of a circular Figure, and armed with three pyramidal Points, placed at equal Distances at the Verge. It seems indeed, that each Cavity in the Surface of the Vesicle is lined with a semicircular Cup with three Denticulations on its Edge, and that it is these which form the pyramidal Bodies; but this I do not pretend all my Care could absolutely find the Way to prove, no Attempt having succeeded to the taking out such a Cup entire. If it be so, the female Flower is more of the Nature of the perfect ones than the male, having this additional Part of the Apparatus of Flowers in general. In the Center of each of these Cavities lies one of the Fruits, and in the different States of Maturity they make a very various Appearance. While the Fruit within is very small, the three pyramidal Bodies in a Manner  
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close the Orifice of the Aperture, their whole Bodies being turned inward and their Points meeting in the Centre. During this State of the female Flowers the male ones are no more than little Protuberances of no determinate Figure ; as those grow to their Maturity, the pyramidal Bodies separate and become erect, and at last recline backwards : The Fruit within encreases all this Time in Size, and when mature, is of a rounded, but somewhat depressed Figure.

Such is the Appearance of the Inside of one of these Vesicles at the Time of their Maturity, and 'tis easy to understand the Process of the Fructification : The whole Apparatus is kept dry by the surrounding Membrane as it ripens ; and at length the Antheræ of the male Flowers burst and discharge their Farina, whose natural Gravity, little as that is, must carry it down to the female Flowers, where it performs its Office and fecundates the Fruits. When this is perfected the Vesicle bursts, the Fruits roll out of their little Cells, and their Gravity carries them to the Bottom, where, if they fall upon the Sand, they perish, but if a Stone, a Shell, or any other solid Body receive them, they produce their Kind.

It might have been natural to have stopped the Investigation here, but the Globules in the female Flowers appeared to me too large in Proportion to the rest, to be single Seeds ; I examined several of them with the largest Magnifiers of the double Microscope, after crushing them with the Point of the Lancet on a Plate of Glass, and in their natural

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Element: The general Violence had hurt many of them, and I plainly discovered that they were in reality no less than Fruits, instead of single Seeds; each being a Capsule, filled with a great Quantity of a most minute Powder, every Grain of which was undoubtedly a Seed; each Particle, so far as the utmost Power of the Microscope could trace it, being of the same equal Size and Figure.

The Bottom of the Vesicle where the female Flowers are arranged, is always indued with a viscid Moisture, while the upper part is ever so dry. The Fruits themselves, when separated, I found to be always covered with a kind of a Mucilage, and on their being burst by the Violence I had offered them with the Lancet, the Seeds did not come out dry, but enveloped with the same Kind of unctuous Moisture.

Such is the Provision of Nature for the minutest of her Works. Bodies so light as these Fruits might, when dislodged from their Cells in the Vesicle, be carried up in the Water instead of sinking; or of the few which escaped the general Destruction of the falling on an improper Bed, the greater Part might roll off from the Pebbles or Shells that had received them, before they burst, or even after they had opened in a proper place, their Seeds, before they could shoot, might be washed off from it: All this might, it all must have happened, had the Fruits or Seeds been left dry. But here is a viscid Fluid like the Slime upon an Eel, which is not to be washed off by the Sea Water, extended over the Surface of the Fruit, assisting it

in sinking, and when fallen on a proper Basis for its future Productions, fixing it there: Nor when it has burst are the Seeds, still smaller, lighter, and an easier Prey to Destruction, from the displacing they might receive by every Motion of a Wave, left to that Fate. The same mucous Fluid covers them, the same Means that secured the whole Fruit in its Place, keeps every separate Seed there so long, that some at least take Place, and produce a Plant like the parent one. 'Tis owing to this that we always see a Number of young Plants of this Species, near the Base of the old one, if it be established on a Place where there is Room; and that while Millions of the Seeds are lost which fall upon the Sand, there are still sufficient Numbers of them for the Continuation of the Species, that are received on Shells, Stones, and other solid Bodies.

However wonderful the Fructification of this Plant may appear to those unacquainted with the Proceedure of Nature in similar Cases, the Naturalist, while he is pleas'd with seeing so much added to the Discoveries in the Science, will recollect that there are other Things, in some Degree resembling it, in the Œconomy of the other Plants; and that under Circumstances where the Necessities are not so apparent. That the minute and tender Flowers, and the Rudiments of the Fruit in a Plant surrounded with Water, and liable to continual Agitation, should not be left expos'd to that Element as those of common Plants are to the Air, seems very rational, and the Necessity of a light Covering, like the Case or Capsule of this Coral-

line, even altogether necessary. But it is not only in the Sea Plants that Nature has made this careful Provision for the Security of the Parts essential to the Continuation of the Species. Tho' in the larger and more robust ones, we see the Rudiments of the Fruit and the foecundating Farina exposed to the Air, only under the slight Shelter of the Leaves of the Flower, it is not so in the minuter Objects. Those may bear the Ruffling of the Wind, but there are others too tender for such Insults, tho' at the same Time too minute for common Inspection. Among the lesser Fungi, which are the Objects of microscopical Investigations, the foecundating Farina, as well as the Rudiments of the succeeding Fruit, are too delicate to bear the least Injury from the Air, and they are preserved as carefully from the Agitations of this Medium, as those of the Plant which has given Occasion to this Essay, from that of the Water. *Micheli* has discovered this in some, and myself in a great many more. There are many whole Genera described in the first Part of my History of Plants, whose whole Fructification is contained during the Process of the Impregnation, in a Case or Covering somewhat analogous to this Capsule of the Coralline, and the Seeds are never disclosed till when the Fruits are perfectly ripened the Case bursts, just as in this Plant, to disclose them.

If we would express a Surprize at this secret Method of Impregnation in Plants, so hidden either by their Minuteness, or by their Place of Growth, from our Investigations, what shall we say when



'tis added, that it is our Unacquaintance only with even the larger and more obvious Vegetables, nay, and those the most familiar about us, that prevents our seeing the same wonderful Process, the same Security laboured by Nature in their Propagation. Who ever saw the Flowers of the common Fig-tree, the Fruit of which is so eternally before our Eyes in every Garden? The Master of the Plantation, perhaps, never missed them, but the Servant, whose Business is about the Trees, for many Ages had looked for them in vain. At length a better Acquaintance with Nature, and the Advantage of Microscopes, led us to the Discovery; and what is there in this seemingly wonderful Organization of the Coralline, that does not shew itself as apparently, tho' the Reason of it is not so obvious in the Fruit of this common Shrub?

The Fig-tree does not produce Flowers which are succeeded by the Fruit, as the Apple, the Pear, and the other Trees of our Gardens do, but its Fructifications are lodged in a Capsule or close Case, as they are in this Sea Plant, and that Case is the Fig, the Fruit itself. The Analogy goes yet farther: There are in the Body of this Fruit, as in the Capsule of the Inhabitant of the Deep, separate, the imperfect male and female Flowers; and these are disposed in the one just as they are in the other, the male ones being placed in the Top, and the female ones about the Bottom of the Fruit; and the Capsule of the Sea Plant, and the Fruit of the Fig, when called by their proper Name, are no other than the common or general Case or

Cup of the Fructifications. In both are contained the Rudiments of many Fruits in female Flowers, and in other Parts of both, the Antheræ, or male Organs of Fructification to impregnate these. Both are preserved in Security within the Covert of the general Cup till the Business of Impregnation is over, and after this, when the Seeds are ripened, the Bursting of the Integuments makes Way for their falling out, to be received into proper Places for the Produce of a Tree or Plant like the former.



## E S S A Y III.

*On the Nature and Properties of an Insect not before known, which inhabits the hollow Joints of the Sea-Plant mention'd in the last Essay.*

**I**T is frequent in philosophical Disquisitions, that the same Enquiry produces very different Discoveries. The Attention that is paid to the immediate Object of the Investigation, does not shut the Eye of the Observer against what else may offer; and the State into which the Subject of Examination is put in order to favour an expected Event, often gives Origin to another not less interesting, tho' beyond the Reach of Imagination in the Observer. Thus it happened to me in the Case of the Sea-Plant mentioned in the preceding Essay: I kept it with great Care in the utmost possible Vigour by renewed Quantities of its proper Element, and preserved it from Motion and Discomposure of all Kinds, that I might see the regular Course of Nature in the ripening its Fruits. The same Supply of a fresh Fluid, and Encouragement of Rest, favoured equally an Observation quite new, and quite unexpected. It was not long before the Dawnings of this appeared in the Course of the other Investigation; but as the Subject of these was in its Nature quite detached from the other, tho' the same Object afforded both, I determined not to confound

an Account in itself sufficiently obstruse, by the Mention of a Matter quite foreign to it, but to make the accidental Discovery the Subject of a distinct Chapter.

In the microscopical Examination of that Plant, I observed that every separate Denticulation was hollow and oval; and that in the Centre of each there appeared a little Aperture communicating with the Cavity within. I observed also, that each of these Denticulations was a kind of distinct Case, its Cavity not corresponding or communicating with that of any other Part of the Plant, but being shut at the Top by the natural closed Extremity of the Denticulation, and at the Bottom by a transverse Membrane. It might have been difficult to explain why Nature, if this Plant was only to be considered as a vegetable Production, should contrary to the usual Course have taken such Precautions in separating its several Cavities: And 'tis from Reasonings of this Kind (where the Principles are not known to those who presume to argue upon them) that the Wisdom of Providence is arraigned. We start with Horror at the Name of the Man, who on hearing the System of the Universe explained to him in an erroneous Manner, replied, That had he been of the Creator's Counsel, he would have taught him to have made it better! But we are to know that we are guilty of no less Impiety, when we censure the Oeconomy of the least of his Works. As a fuller Explanation of the Heavens threw the Censure in this Case not on the Almighty Hand that formed them, but on the ignorant Mind that presumed

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presumed to describe and explain before he understood them; so in the most minute as well as in these the greatest Objects of our Attention, 'tis our Ignorance only, that leads us to censure the Disposition of the Parts; and a more perfect Knowledge will as surely lead us to reverence and adore their Author in one as in the other.

In however unnecessary a Light the Separation of these several Cavities in this beautiful Plant might appear to him who considered it only as a Vegetable, the Distrust will turn to Admiration when we see them each the Habitation of an Animal. I don't wonder that this had not been discovered before; it does not appear that the Plant itself was ever brought to a fair Examination; and even under all the Advantages in which I observed it, the first Appearances that made Way to the Discovery, would very naturally have led to a Mistake, on viewing the several Parts of the Plant from Time to Time. It appeared at first, within the Compass of an Hour after the giving it fresh Water and allowing it perfect Rest, that the Apertures I had observed in the Centres of the Denticulations were not open in all: They appeared in some under the Form of Spots of a bluish Colour; and as the Observation continued, these Spots grew more and more numerous, and the open Holes fewer and fewer. I retired from the Observation full of Doubt about this Change of Appearance, and suspecting that the continued Attention had made me less in a Condition to distinguish with Exactness. After a Recess, no longer than was necessary to prepare my Eyes by Relaxation for a new Scrutiny, I returned

turned with great Caution not to disturb the Plant. The Face of Things was now greatly changed; instead of a simple Spot or a flat Covering, as it appeared to most of the Holes, there arose from all of them, certain erect and prominent Filaments. Two of these with great Regularity, raised themselves from each Aperture: They were of about half the Length of the Denticulation, and of a pale blue Colour. On examining them with a moderate Magnifier, they appeared of a glossy Surface and tender Structure, and were not perfectly of a Thickness all the Way, but largest at the Top, and that in so regular a Manner, that the greater Part of their Length seemed only to do the Office of a Pedicle, supporting on its Top an Oval Head, rounded or gibbose on the exterior Surface, and there perfectly smooth on the Superficies; on the inner Side flat, and there granulated.

In the Eagerness of Heart that attends a Discovery of this Kind, I at first Sight of these persuaded myself that I had made out the whole Process of the Fructification of the Plant at once: The Capsules which I had not then examined had all the Appearance in the World of Fruits, or the Parts of female Flowers; and nothing could appear more likely than that these oblong Bodies were the male Flowers, the very Figure of them perfectly resembling that of the Stamina, supporting on their Summits the Antheræ in a perfect Flower.

While I was congratulating myself on the Success of the Care I had taken to keep the Plant in Vigour, and on the shooting out of such a surprising Number of these Antheræ, there appeared at the  
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Bases of two, toward which the Glass was immediately directed, two others shooting up and lengthning under the Eye as I examined them. I now began to form new Expectations of the Event of these Observations: These it was evident could not have a vegetable Origin, and it therefore no longer appeared to me now that the other had. These at their full Extent, were not of a third of the Length of the others, nor were they of the same Form: As those were all the Way of a Thickness to the Top where stood an oval Head, these were largest at the Base, and became smaller all the Way to the Summit, where they terminated in a Point: And as those were smooth on the whole Surface except on the inner Part of the Head, these were all the Way from Top to Bottom smooth on their outer Surface, which was convex; and granulated all the Way along the inner Surface, which was plane.

These Objects had not long been extended to their full Dimensions, before they gave Proof of their being of animal Origin by their Motions; the short ones were in a continued Vibration backward and forward, and the longer Pair twisted themselves about in various Directions, sometimes applying their flat Surfaces to the Plant, and sometimes clapping them against one another. It appeared that after a few of these Motions, they grew longer; but on casting my Eye down to the Base of them, this was found to be otherwise; there appeared there a round Body thrusting itself up out of the Aperture to some little height, and as it seemed fixing itself to the Surface all about the  
Hole

Hole by a Multitude of slender Filaments. The Motion of the four oblong Bodies now became more and more free, and it was no longer a Doubt but that what now offered itself to View, was the Head of an Animal, furnished by Nature with these four Parts for the assisting itself in the procuring its Prey.

Assured thus far of the Nature of what I saw, the next Step was to find Means of viewing so extraordinary a Creature in a more advantageous Manner. The Glasses used to examine the Appearances of the Bodies kept in Water in a Glass Vessel from the Outside, could be but of a very limited Efficacy as to Magnifying, tho' capable of being of infinite Assistance in Comparison of the Powers of the naked Eye. I was at some Pains, after taking off a little Branch of my Plant, to dissect several of its Joints while it lay on a Plate of Glass in some Salt-water, in order to disengage the animal Inhabitants. On the Motion given to the Water in the Vessel by introducing the Scissars with which the Piece was cut off, the Animals had all withdrawn themselves into their Cells again, so that I had no Direction now for the finding one, but a Supposition that there was one in every Cell, I opened a great Number of them with a fine Lancet, keeping the adjoining Part of the Plant fixed down by the Point of a Needle held by an Assistant. In several I found none, in most I could distinguish the Creature; but it was not till after many Trials that I had separated several, one of which I found entire: This I placed in a little Water before the reflecting Microscope, and as it was perfectly



perfectly lively and full of Motion for some Time, I had an Opportunity of seeing its Form and Structure to great Advantage.

The Body was of an oblong Form, its Length equaling four times its Diameter: It was not flat, but rounded in the manner of the Body of a Worm, and its Colour a pale Blue: Its Head was of a rounded Form, and its Tail truncated: Its Eyes were small but distinguishable, and its Body covered with Tufts of Hair. This was all at first discovered in it, but as it put itself more in Motion, and after a Time died by the Evaporation of the Water, the Continuance of the Observation thro' the several different Periods, gave me an Opportunity of seeing its whole Form and Structure.

After the Confusion of placing it before the Microscope and darting upon it a Quantity of Light, which it could not have been used to, was over, the first Signs of Life which it gave were by a Motion of its Tail; this it turned about in various Directions, applying it to the Glass on which it lay, turning it up again, and moving in every Direction. In the several different Positions in which its Extremity offered itself to View, under these Contortions I had abundant Opportunity of seeing that it was hollow. It has a round Cavity of but small Depth, capable of Contraction and Dilatation at its Orifice, and surrounded with a Number of a fleshy Fimbriæ or flat Filaments. The whole Body, as already observed, is covered with Hairs; but these tho' as slender as the Hairs, are quite of a different Appearance, and evidently shew themselves

felves to be of a fleshy Structure. After a Multitude of Contortions, the Creature applied the truncated Extremity of the Tail close to the Surface of the Glass; and fixing the whole Rim of the Cavity evenly down, fastned itself by it, in the Manner in which we see Children in Play fasten a round Piece of wet Leather to a Stone, in order to lift it up by Means of a String which is in its Middle. The Use of the Filaments that furrounded the Verge of this Cavity, was now also evident they were extended every Way to their full Length, and served as so many Cords to assist in the fixing the Body in its Place, each of them being fastened down its whole Length to the Plate of Glass.

It seems necessary by this Apparatus, that the Animal should have a Power of fixing itself in a very firm Manner by its Tail to whatever it is upon. The Securiry of the Lodgement it has in the Joint of the Plant renders a Care of this Kind in Nature unnecessary, and I could by no Means reconcile myself to what I saw, till on examining the Surface of the Plant in the other Glass, and carefully looking over the little Stones, Shells, and other Matters brought from the same Place with this Plant and preserved also in Sea-water, I found Multitudes of the same minute Animals living on them. The Use of this Apparatus was now obvious enough. The Creature is extremely tender in its Structure, and if not capable of fixing itself in this secure Manner when on the Surface of a Plant or other Body, must be liable to Destruction by being washed away by every Motion of the Water. Conscious of its own Weakness, it seeks Shelter where-

ever

ever it can find it ; and when it is well lodged, this Apparatus of the Tail may be unnecessary ; but in its other State it is its immediate Preservation. I found many of them in the little Cavities of Stones, many between the folding and scaly Coverings of Shells, and a Number in the spiral Lines of the common Wilk-shell : They seem every where to have sought with great Attention for a Place of Security, but never to have found it so happily as in the Joints of this Plant.

When the Creature under my Observation had fixed itself by the Tail, it began to move its Body about with great Ease and Alacrity, the Eyes became more distinct than before by the drawing back of a Membrane which had in part covered them ; and near to them but a little higher, or more toward the Extremity of the Head, appeared two oval Bodies, which I knew by their Shape to be the Heads of the two longer Arms with their rounded and glossy Surface upwards. These I found were always applied in this Manner, with their flat Side close to the Head in a time of Rest ; and their Pedicles which supported them when extended, are like the Horns, as they are called, of a Snail, capable of being drawn in and thrust out again at Pleasure. It was not long before I had convincing Proof that this Opinion was right. I saw the two Heads instead of being flat, raise themselves into an erect Posture on one End, and immediately after they were carried higher, and the Pedicles began to shew themselves.

The whole Surface of the Pedicles and the outer Surface of their Heads, were smooth, glossy, of

a bluish white Colour, and covered with a mucous Matter like the Body of a naked Snail, but the inner Side of the Head which is flat, and which I had before discovered to be granulated, now made a surprising Appearance. Each of the Granulations appeared to be of a hollow Form like a Cup, narrowest at the Base, and widest at the Rim, and the Verge surrounded with a Series of minute and scarce perceptible Hairs. I afterwards found that these several Cups were either all together or any one of them severally capable of Contraction and Dilatation at the Pleasure of the Animal, and that they stood so close that when their Mouths were fully opened, they touched one another at the Edges, and only left a few irregularly formed Apertures between them. In this State the general Surface appeared almost smooth, in the other Extreme of Contraction, each of them was drawn into about a third of its former Diameter; and it was in this State that it appeared so manifestly granulated.

Soon after the Elongation of the Pedicles of these, the two shorter Arms, if they may be so called, began to protrude themselves, these had been before wholly invisible, not even their Points appearing above the Surface of the Skin of the Head. The whole inner Surface of these I have before observed was covered with Granulations, and those now appeared to be of the same Form and Structure with the others, hollow, and capable of Dilatation and Contraction at the Creature's Pleasure.

These four Arms were no sooner extended to their due Length, than they were put into Motion,  
and

and that in a very variable Manner; sometimes the two longer ones moved, sometimes only the two shorter; and at certain Intervals, tho' this more rarely, both Pair together. The Motion of the longer Pair consisted of Protrusion and Retraction, of Erection and Depression, and of Convolution from Side to Side, all performed with great Ease and Rapidity. Sometimes the two Extremities would be applied to one another Flat to Flat, and in a Moment separated again and thrown back to the utmost Distance; and at other times they would strike themselves with Violence to the Plate of Glass. The Motion of the shorter pyramidal Pair was not so swift nor so varied, they were sometimes raised, and sometimes depressed, and at Times they bent themselves in various Convolution, and threw their Extremities from one another to greater or lesser Distances.

During these Motions I had an Opportunity of examining their Form with great Attention; and as they occasionally left every Part of the Head of the Animal open to Observation, I searched with all Diligence for the Mouth, but could discover no Aperture in any Part of it. After a great many Repetitions of all these Motions, the Creature, as the Water in which it lay began to dry up and the Light reflected from the Speculum of the Microscope, grew more and more offensive, became faint and feeble: At length it extended its longer Pair of Arms to their utmost Length, and applied the flat surfaces of their Heads to the Plane of Glass never to move them again: The shorter pair of Arms soon followed their Example; they also

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extended themselves to their utmost Dimensions, and applied their flat Sides close to the Glass. In a Minute more the Water was all gone and the Creature dead.

On turning the Glass with the other Side upwards, I had a happy Opportunity of seeing the real Form of the Granulations on the Surface of the Parts that were now applied to it. The Creature had extended them all to their full Expansion, and they were fixed in that happy State for Observation. They resembled so many Saucers used to set our Tea-cups in, their Cavity was shallow, and their Rim surrounded by a kind of Cord; the Part of which that was now applied to the Glass had been pressed by the muscular Power of the Animal into a Flatness, and was fixed down by a mucous Matter hardened into a kind of Glue. The Fimbriæ which I had before discovered round the Edge of every Granulation, and which at that Time had the Appearance of Hairs, I now saw were fleshy Fibrills, like those which surrounded the Tail, and contrived for the same Purposes. They had their Origin from the back of the Cord or elevated Rim of the Cavity, and served to fix it down to the Plane with a greater Strength. They act also in another Capacity on Occasion, serving to close over any Insect that may be received into the Hollow, in the Creatures searching after Prey, and confining it as a Net. I was at the Pains to count the Number of these in what I determined to be about an eighth of the Circumference of one of the Bodies, and numbered twenty-seven; so that each of these single Granulations has  
more

more than two hundred of these Filaments to play about its Surface, to entangle any minute Creature destined for the Prey of this Insect, and to envelop it and prevent its Escape when lodged there.

When I had satisfied every Doubt in regard to the Structure of these little Parts of the Apparatus, it remained to examine what I had not yet looked at, the Bulk of the Animal. To this Purpose I turned up the Glass again and added fresh Water to the Place where it lay, and after a few Moments saw it swell to its first Dimensions and reassume that Gloss and Lustre which it had lost on the Evaporation of the former Water and its becoming dry. The Body at first Sight appeared to be covered with Hairs, but upon a close Examination these appeared not to be indiscriminately scattered over its whole Surface, but placed with great Regularity. It was easy to see the naked Surface of the Body between the Tufts of these: This was of a blue Colour, of the glossy and mucous Appearance of the common naked Snail, but not wrinkled as in that Creature, but perfectly smooth. The Colour was that of the Inside of many of the Sea Shells, a fine glossy radiant White, with a considerable Tinge of a pearly Blue, not diffus'd regularly thro' it, but seen as a changeable Colour.

At small Distances there rose from the Level of the Body Circles of little fleshy Tubercles, resembling Warts: These were low, depressed, and of a bluer Colour than the rest of the Animal; and from the Summits of these arise the Hairs in considerable Tufts, each furnishing a Kind of Pencil. The Number of single Hairs on each cannot be so

small as five hundred. In this Manner therefore are the Hairs of this Animal disposed in Tufts, not singly, and those Tufts stand on fleshy Tubercles in a circular Form, surrounding the Body at small Distances with naked Spaces between. It is not easy to say what is the Colour of these Hairs, nor indeed to describe their Beauty. They have all the Colours of the Rainbow, Gold, Purple, and fiery Red, in great Glory, and above all, the rich shaded and varied Green and Blue, which we see on the Neck of a Drake or Peacock. Which of these Tints, or whether any of them be the Ground Colour of the Hair itself, there is no determining. They shew themselves in Succession in the Manner of the Colours on a changeable Silk, or to use a much more apposite Allusion, like the bright Colours of the Opal, not one of which is in that Gem the ground Colour, that being a pale Grey.

In describing what I first saw of this Insect when raising its Head and a Part of its Body out of the natural Aperture in the Joint of the Plant which it inhabits, I mentioned a Series of Fibrills which it extended on every Side, to fix it in its Place. This Observation of the Body of the Animal, under the Advantages of perfect Rest, and a larger Power of magnifying, explains that Matter perfectly. Those Fibrills are these Tufts of Hairs. The Creature at its Pleasure raises one or more Joints, if they may be so called, of its Body out of its Cell, and wherever it chuses to rest there is one of these circular Series of Tubercles laid upon the Verge of the Aperture in the Plant, and the several Tufts of Hairs separated and extended by  
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the Medium, resemble a circular Range of Fibres or Roots. There is another of these Series also just within the Aperture, as they stand at very small Distances on the Body, and consequently the Creature is kept firmly in its Situation, and not at all liable to be driven in or forced wholly out of its Case by Violence, tho' its own muscular Power of contracting or dilating its Body, and rendering these Tubercles rigid or flaccid, makes it easy for it to move either Way at its Pleasure.

The Form of this singular and hitherto unknown Insect, being thus perfectly understood, it remained to enquire into its Manner of feeding: A Circumstance about which all the Examinations hitherto made had left me perfectly in the Dark. There are no Species of Animals so extremely rapacious as those minute Creatures, which are not visible to us except by the Assistance of the Microscope. If the Birds or Beasts of Prey destroyed but a hundredth Part of the Number of Animals that fall a Sacrifice to the Hunger of these Minims of Existence, the Earth, on the present System of Things, must in a few Years be left without its brute Inhabitants: But Nature, wherever she has implanted the Means of such Destruction, has provided a Supply necessary to the preserving the Species beside answering all its Calls. There is indeed no Series of Observations under which we so strongly see the infinite Wisdom of the Creator pointed out to us, as these of the minutest of his Works; nor is it a little Humiliation to our Pride in our own Dignity and Importance, that he has placed so many Attestations of his Attributes out

of the Reach of our natural Organs, and consequently beyond the Acquaintance of the far greater Part of the World.

I could easily conceive that all the Motions I had hitherto seen in the Animals kept in salt Water with their Habitation-Plant, had been in Attempts after Food; but in what Manner that was to have been devoured by a Creature in which I had not been able to discover a Mouth, was a perplexing Difficulty to be explained. To suppose, as the Hurry of a modern Naturalist would have been ready to do, that each of the Apertures in the Arms was a Mouth, were too much out of the Course of Nature. It was no Wonder that I had yet no Opportunity of seeing them feed, since the Water in which I had kept the Plant they inhabited, was but an artificial Sea Water, prepared by Salt dissolved in common Water. The Sea abounds with Insects of the minutest Kind, as well as with Animals of the largest. The Microscope discovers in every the smallest Drop of it, Millions of Animalcules of various Forms and Sizes, and 'tis on these that the larger Kinds, such as the Insect now under Consideration (for such it is in Comparison of them) feed. Our fresh Waters from Ponds, Ditches, and other stagnating Places, are as fully peopled with minute Existences of the animal Kingdom; not a Drop from any of them but furnishes Millions. The Water which I had chosen for the sake of its Clearness, was not of this Kind, and if it had the Salt added to it, would have instantly destroyed all the Inhabitants.

The Method of feeding these minute Sea Insects is after they have been kept awhile in salt Water, uninhabited by any thing living except themselves, to put fresh Water from some standing Reservoir in the Place of the salt, and tho' Sick with the Exchange, as they are unprovided with their usual Food, they will then seize upon any thing living that they find there. Soon after the Plant's recovering its Place, and the new put in fresh Water being still, I saw Multitudes of Heads and Arms thrust out at once, in Search of the Insects that crowded one another in every Part of the new Fluid. I found it would be difficult to see with the Precision I wanted from the Apparatus fixed on the Outside of the Glass: I cut off a small Branch which I saw well inhabited, from the Top of the Plant, and put it, with some of the fresh Water, into one of those concave Glasses which are usually sold for this Purpose, as Part of the Apparatus of the double Microscope.

This was no sooner placed in the Focus of the Magnifier, than I was entertained with a Sight to which I wished to have had a thousand Witnesses. The Water had been taken from a large Pond in the Fields behind *Montague* House, and was fuller of Animalcules, and somewhat larger Insects, than I think I ever saw any. These played about in every Part of it unmolested by and unconcerned about their Change of Place, or any Shock the Motion attendant on the doing it had occasioned. I was entertained with seeing them following and preying on one another, and with tracing the Chace of a larger after a smaller, both perhaps invisible,

except by the Microscope ; while one of a yet larger Kind was close behind pursuing the Pursuer, and as ready to devour him as he to gorge himself with the other. The Inhabitants of my Branch of Coralline were of a more timid Disposition : It was some few Moments before they appeared, but at length the Tops of the larger ones began to shew themselves, then the shorter, and in due Time the Head itself. The Discovery made by the Eyes of such Plenty of Prey, gave an instant Vigour to them all : The Heads no sooner appeared than a Part of the Bodies followed, and some were so eager, that they fell out of their Cells and descended to the Bottom of the Glass.

Various are the Arts of Death, not only from the mischievous Inventions of Men, but from the Provision of Nature for its several Productions. Such a Scene of Butchery, so universal, so varied, and so hurried in all Parts, human Cruelty itself never offered. It would not perhaps have been easy for the Inhabitants of the Fluid to have escaped these Devourers by all their Arts, but Nature, which gives to every Animal an Instinct to discern, and some Means or other to resist or to avoid the Creatures which will be aptest to destroy it, had made no Provision against so strange an Incident as now carried on the Destruction of her little Legions. The Beasts of Prey, if it may be allowed me to call these Animalcules such in Comparison of the others, were Enemies that never could naturally attack the Creatures that were now their Victims ; they were Devourers brought as it were from a  
 other

ther World, and Assailants against whom no Form of Defence had been concerted.

As the Creatures which were the Objects of this Destruction were of various Forms and Sizes, various Means of Death were used against them, and every one of the hungry Inhabitants of my Coralline seemed like a Briarius, crushing different Objects at one Instant in his different Arms, and dealing out Destruction several Ways at once. If the Object of Prey were small, a single Granulation on the Head of the longer Arm, or on any part of the Surface of the smaller seized it at once, and directed it toward the Head: If larger, several of them grasped it at once; if too robust to be held with Ease in that Manner, the flat Surface of the other Arm was brought in to its Assistance, they were clapped together with a Violence that crushed the unhappy Creature to Pieces, and to which ever of them it then adhered, that was instantly bent toward the Head of the Animal. If a longer Animalcule came in the Way, the shorter Arms, which were all over Granulations on one Side, seized on it and twisted it to Pieces with their Contorsions; and if a yet larger and more troublesome Creature offered, for Hunger now made them seize on every Thing, all four were employed at once to demolish it.

It was with a Mixture of Pain and Surprise that I saw twenty or more of these my Coralline Animalcules dealing Destruction so many Ways at once, among an innocent and defenceless Race; but to comprehend the Process of the Creatures eating what it thus destroyed, I was obliged to  
confine

confine my Area, and adapt larger Glasses to take in only a single Object at once. I luckily had a very vigorous Animal on this new Regulation immediately in the Focus of the Microscope. It was so far wearied with Slaughter that its Motions were slower, and consequently more easy to be watched; and as it had already satisfied the Ravening, tho' not the utmost Cravings of its Appetite, it was the more easy to be understood in all its Economy. Happily for the Observation, this was one which had on the first Onset thrust out its Body a great Way from the Cell; and it had not, or perhaps in its distended State from such a Quantity of Food, it could not draw it back. I saw it still destroying: The first Object that occurred for its swallowing was a round Animalcule, pellucid as an empty Bubble, and seeming to promise very little for its Nourishment: This was seized by one of the Granulations on the lower Part of one of the shorter Arms. I could see the Cup contract upon it the Moment it was received, and the Fibrills that ornamented its Edge throw themselves over it. After an Instant thus spent, in which I am persuaded the little Creature was pressed to Death, the Verge of the Cup opened, and the Fibrills of the upper Part of it, in their drawing back took the Creature with them and delivered it to the Fibrills on the Verge of the Cup next above it. It was in a Moment rolled over the Hollow of that Cup, without either the Verge contracting to close upon it, or the Fibrills converging over it, and delivered by the Fibrills of its upper Verge to the lower ones of the next. In this Manner I

saw

saw it rolled along the whole Space of the Arm up to its Top, with a most amazing Rapidity and Accuracy. When arrived at the Summit it was received by a larger and deeper Cup, which I had not before observed, but which I now found terminated each of those Arms, and by that delivered somewhere, but it was impossible for me to see where. The Arm lengthened itself at the Point as soon as the Prey was fixed in it, and turning over the Head came back in an Instant without it.

It was easy for me to conclude from this, that the Mouth was somewhere in the under Part of the Head ; and it was with some Pains that I at length turned the Object in such a Manner as to get that Part of it within the View of the Microscope. In this Situation it was when one of those minute Inhabitants of the Fluid, which the Microscope discovers to be somewhat of the Shape of a Caterpillar, rolled its unweildy Back toward the Part of the Water where it was, and unhappily for itself, fixed on the Plant just below the Aperture of the Joint at which the Body of the Animal now stood out. The Creature had no sooner discovered its Prey than the Tops of both the longer Arms were brought to bear upon it, and by a sudden closing together crushed it to death. I had yet been able to discover no Mouth to the Animal, but now a Membrane drew back from the Middle of the Neck of the Creature, and discovered an Opening of a semilunar Figure which gaped for its Prey. The Arm, to the Top of which the dead Animalcule hung, drew itself toward the Mouth by an easy Motion, the Creature was received into it in

an instant, and the Membrane immediately after flying up into its Place as if it had been all the while before held back by Force, covered the whole Aperture, and made no Appearance at the Place where it joined the rest of the covering of the Neck, unless that of a circular Fold or Ring, such as we see on the Bodies of almost all the Insects.

Such is the History of an Animal, hitherto quite unknown to the World, the Inhabitant of a Plant known only by its external Form, and by that so imperfectly, that it is not easy to find from all that the botanical Writers have said on it whether any of them had seen it in any Degree of Perfection. As both the Plant and the Animal have been very thoroughly examined on this Occasion, and happened to be in a State to give the best Proofs of their Nature on such an Examination, it may be no improper Place here to speak in general of the New Doctrine established in regard to the Sea Plants by some Persons who had seen but imperfectly something of what has appeared in the Process of this Investigation.

That every Cavity in every solid Body which lies under Water affords a Recess for some Animal or other is certain; many of them to a thousand different ones, and many different Cavities to the same Species. The several Folds of the Oyster-shells, the spiral Hollowings of the Wilks, and other turbinated Shells, the longitudinal Furrows of the Cochleæ and the very Species of the Murex, which have them foliated and hollow, are all while the several Shells are in the Sea inhabited by Numbers  
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of Animalcules. The Sea Plants in the same Manner afford Cavities which are as much inhabited as those, but no more so.

The Vegetation and Means of Accretion of the Sea Plants in general as they have no Roots like those of the Land, has perplexed many Naturalists, and is a Subject that shall be treated at large in one of these succeeding Essays. The *French*, who have been very pretty Piddlers in natural Knowledge of late Years, tho' excepting for the Discoveries of their immortal and indefatigable *Reaumur*, no great Matter has been really added to the Science by them, had at Times found these animal Inhabitants in the Coralls and in others of the Sea Plants. *Jussieu* in particular, in a Treatise which he has published on the Coralls of the Baltic, finding these animal Inhabitants very numerous in several of them, has given it as his Opinion that those Sea Productions are not Vegetables as has been generally supposed, but that the Coralls, Corallines and the like, are in reality no more than Cases or Cells formed by these several minute Creatures for their Habitation. What a System! to make the regular Shoots of red Corall, the ramose and elegant Shrubs of White, the tender and delicate Composition of the Corallines, finer than any of the Land Plants, all the Structure of little inconsiderable Insects which have chanced to find a hiding Place in them.

The happy Discovery of the Fructifications in this Coralline is alone sufficient to overthrow the whole unnatural System, but there are a thousand Instances more of equal Validity to prove it. I have  
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been grieved to see *Linnæus*, an Author too fond of Novelty, whether the Product of his own Brain or of another's, adopt this System : But I know he has with all his Flights so much Truth and Candour in him ; and has so much at Heart the Promotion of natural Knowledge, that notwithstanding his Dislike to Microscopes, he will repeat this Experiment from me ; and when he has seen what he will so well understand in the Vesicles of this Plant, I am confident he will give up the Author of this irrational System, and restore the Sea Plants to the Place they have hitherto held in the Rank of vegetable Productions.



ESSAY IV.

*On a peculiar kind of Sand found on the Shores  
of Minorca.*

**T**HE natural Productions of the distant Parts of the World, whether of the Animal, the Vegetable, or the Mineral Kingdoms, are many of them so extremely different from those of our own, that judging by what we see within the narrow Limits of this little Island, and in general of but some very small Part even of that, we are apt to discredit the Relations brought us by those who have been elsewhere. I would not infer that there have not been People, who, naturally fond of exciting Admiration, have invented incredible Stories and vouched for their having been Witnesses to them in some remote Part of the World; but giving up all the serious as well as jocosè Lilliputian and Brobdignaggian Histories, there remain a thousand Things wonderful in the highest Degree to us, tho' familiar to those who have been more conversant with the World. 'Tis a mean and narrow Partiality to our own Country to suppose the Accounts of Things produced in others are false, because they describe them as more elegant, great and valuable, than those of our Own: We have Advantages in the moral System of Things that may well support us in holding our Island above all upon the Earth; *England* is the Country of Literature and Liberty; may she enjoy that Title for ever,  
and

may her Sons be proud of it; but in the natural World nothing less than a ridiculous Partiality can lead us to suppose we excel, or make indeed any Approaches toward equalling the *East*, the *American* Dominions, or even the neighbour Continent. Gold and Gems, whence come they but from the remotest Places? While we command them we must not deny that other less happy Countries produce them. The Savages of the Desarts, tho' mischievous, yet wonderful, Nature, while she has denied, us the more desirable Children of a nearer Sun, has kept from us also these, and we have scarce a Serpent that is either beautiful in its Colouring, or fatal in its Bite. The Viper, the almost only Reptile we have of an real Terror among us, tho' supposed capable of inflicting a mortal Wound, has scarce ever, perhaps never, been known absolutely to occasion Death.

We are not to favour a Partiality to our own Productions to the Encouragement of Ignorance on the Subject of those of other Places, nor to indulge the limited Conceptions that an Ignorance of the World would confine us under: We are not to discourage an Earnestness in discovering or an Openness in communicating what has been seen by denying our Assent to Things, because new or strange, or to repay the Man who would instruct us with an Impeachment on his Veracity. Every Thing that is new is strange: Familiarity with Objects alone can make our Conceptions of them sit easy upon us. The Effects of the Magnet! would any Man have believed them who had not seen or heard of them before! yet there must  
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have been a Time when they were new to all but the Discoverer, and where that Discovery must have been liable to as much Unbelief, and he that spoke of it as a Fact to as much Contempt as the Asserters of any thing new to us now. Even within these twenty Years would any one have believed that a Man could at his Pleasure communicate that amazing Quality to Iron! or if a Person of Science had been informed of the apparently impossible Means by which this was to be done, would he not have disbelieved the one and laughed at the other? Yet we have seen the Fact from *Savary*, and his first Attempts in it, to the Completion of all that could be expected from it in the Labours of *Dr. Knight*. Electricity might be produced as another Thing, the Effects which we believe upon the Conviction of our Senses, but which we should have been, I am afraid, very apt to discredit had we only heard of them. Multitudes of other the happy modern Improvements in Science might be called in to elucidate this, and plead for our Belief, at least to discountenance that Contempt with which we too frequently receive the Notices of new Discoveries or Accounts of Things, different from those with which we have at all Times been familiar. The great Purpose of these Essays, is by some new and singular Discoveries to introduce the more known Parts of *Natural History* and *Philosophy* in a familiar and intelligible Form to the Acquaintance of Numbers who are yet Strangers to them; and as the setting the Minds of every Body right in regard to the Principles as well as the peculiar Objects of these Studies, is a great Part of the Attempt,

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the Reasonings upon the most general Subjects must not be esteemed Digressions from the particular Objects of the *Essays*; since it is in some Degree at least for the introducing of these that the Objects themselves are selected.

In this View to descend from the more abstruse Sciences to those which are more immediately the Theme of these Investigations, who would have believed at a first Report, unless guided to it by such a general Sense as this of the vast Variety of Nature, and the little our little Spot can shew us of it, that there was such a Creature as a Bird in a Manner without Feathers, the Coffowary? another with such a Beak as the Brasilian Magpye, larger than its whole Body? or that an Animal like the Polype, had a Principle of Reproduction of the most essential Parts, the Head, and Organs of Sensation and Digestion, within itself, and that no Part ever so small could be cut off from it which would not reproduce all the different ones and become an entire and perfect Animal? The Brasilian Fishes, is it not beyond all Conception founded only on what we see about us that there can be such? And who that had seen nothing of the Bird Kind larger than the Swan or smaller than the Wren, would have but a general Belief that Nature could do more than he has seen? or have credited the Accounts of an Ostrich taller than the Horse and his Rider, or of the Humming Bird, smaller than the Bee, and worn as a Pendant in the Ears of an *American Beauty*? *Martegrave*, when he described the Productions of the *Brasils*, was suspected to have figured Creatures of his own Imagination; but tho'

one Age supposed them Fictions, the next had Proof that they were Facts.

It is not only in the more eminent and distinguished of her Productions that Nature shews more Profusion of Excellence in those of other Countries than of our own; the same Observation may be made in those which we hold most inconsiderable. The Sand which dirt's our Feet in this Country, is on the Coast of *Afric* pregnant with Gold, and in some Parts of *South America* with Fragments of Gems: An Object of this Kind is the immediate Subject of the present Essay; but before I enter on the Description of it, it may be proper to determine what is generally, since that is not exactly what should be properly, understood by that Word.

We are apt to apply the Term *Sand* to any hard stony Matter which we find in form of Powder, be the Particles of which that Powder is composed coarser or finer. We are to know however, that there are two very distinct kinds of Things that occur to us under that Form; the one a coarse Powder naturally and originally such, the other, an unconnected Quantity of Particles of Matter, being indeed in their present State a Powder also, but which have at some Time been united together so as to form a kind of Stone. We have in *England* Stones, which tho' tolerably firm while in the Earth, yet, contrary to the Nature of other Kinds that grow harder on being expos'd to the Air, are no sooner laid open to its Effects than they moulder into loose Particles and form a kind of Sand.

The Opportunities of their being thus disunited within Land are but rare, but when such Stones, and  
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there are Multitudes of different Kinds of them, are exposed to the Air in the Cliffs on the Sea Coast, they moulder gradually, and the Powder that falls from them runs down to the Shore and discovers itself in a long Course as far as to the Water. We have of these on the *Scotch* Coast, but they are not very singular: In the *East* they are formed of disunited Stones of greater Beauty, and consequently themselves make a more elegant Appearance; nor are there wanting Instances of very beautiful ones near home.

I had been frequently told by the Gentlemen who went backward and forward between *England* and *Minorca*, that there were Sands running down in this Manner on the Shores and out of the Cliffs of that Island, which had all the Beauty of the finest Marble, and all the Lustre of Gems; and that when the Sun shone upon them, they were so bright that the Eye could not bear to look at them. I had been earnest in my Request to obtain some of these elegant Powders, and about two Years ago I succeeded: I imagined by the perfect Silence of every Body on this head, that my Specimens were the first that had come into *England* of so curious a Production: I waited on that Father of *Natural History* among us, Sir *Hans Sloane*, with a Quantity of the most beautiful Species as a Present; but I found he had already many Years ago received it from the same Place. It appeared strange to me that so singular a Thing should have been so long known among us, and all the Time undescribed and unexamined: I increased the Specimen of my honoured Friend with the Addition of what



I had brought, and sat down to a careful and thorough Examination of the rest.

To the naked Eye it appeared as it had been described to me, a most beautifully variegated Matter, perfectly clean, and of the Lustre of a polished Gem. It was not so very fine a Powder but that it was easy to distinguish its Particles, and to observe that they were of three Colours: Some were of a bright snow White, some of a pale fleshy Red, and others of a strong and elegant Green, all bright and glossy, and the green and white ones in some Degree transparent.

The Microscope discovers common Sand, and all other Things that are properly so called, to be composed of similar Particles, all of them of a stony Nature, all of them indeed real Crystal, obscured more or less by an Admixture of Earth, and tinged to different Colours, the Principal of which however are the several Shades of Yellow, by the Colour of that peculiar Earth they have imbibed. All these Particles have an apparent Tendency to some angular Figure, and all to the same. They are therefore so far regular; and it is evident that this angular Figure is that which they would have assumed in more Perfection and Regularity, if they had been at Liberty to shoot in their own Form, without the Load of that foul Earth which has thus prevented them. This is the Case in all the Sands, properly so called, from the purest which we strew over Writing, to the coarsest. On the contrary the Powders, which tho' they at present assume the Form of Sand, have been the constituent Matter of some Kind of Stone, are composed of irregular  
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and indeterminate Particles; the Microscope discovers this, tho' the naked Eye does not; and of this Kind was the Powder received under the Name of Sand, and now to be examined.

The double Microscope is not at all proper for the Examination of Bodies of this Kind. I took out one of the single ones, the Lens or Glass of which is set in the Centre of a silvered concave Speculum. On fixing between the Points of the Forceps of this Apparatus a Piece of white Paper, about equal in Size to the Area taken in by the Glass, and after gently wetting it in my Mouth, dipping it into the Parcel of Powder, it took up a sufficient Quantity of the Particles for the Examination. The natural Viscosity of the Saliva serves, in this Case, as a Cement of sufficient Strength to hold the Particles fast on the Paper, and on throwing the Light of the Speculum fully on the Congeries of them that had thus been placed together for Examination, the Effect to the Observer was scarce to be described. The Power of magnifying by a single Lens in this Kind of Microscope, is vastly inferior to that by the double one, but it was enough on this Occasion, and it takes in a larger Space. The Objects were singly much larger than the Animals usually examined by the other, and it was not necessary to enlarge them to that Extent for the Observation.

The Eye under this Advantage however was directed to what now appeared not an inconsiderable Bit of Paper, of the Bigness of a Barley-corn covered with Dust, but the Object appeared a Plane of a white Colour covered with massy Stones, of the  
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irregular Figure of those with which our Streets are paved, but of a Beauty surpassing every Thing that Nature offers of that Size. The White were so many Masses of the brightest Crystal, tinged with a milky Hue, that was itself so elegant as to leave one no room to complain of the want of Transparency, which it in some Degree took away. The red Pieces were like nothing that Nature affords us in a larger Size ; if it could be possible to conceive Cornelians of the true flesh Colour, a fine pale but blooming Red, these were such. They were less transparent than the White, but more glossy, and equally coloured throughout. The green Particles were more beautiful than either, they seemed so many Fragments of the purest Jasper, only clearer than any Stone of that Name ever was, but clouded and too obscure to give the Resemblance of Emeralds.

The Eye could scarce be tired with looking upon a Series of Gems, created thus as it were by the Apparatus, and so far exceeding in apparent Magnitude, as well as Beauty, all that Nature ever formed. Their Figures were not like those of the proper Sands, regular, or with any Approach to Regularity, but rough, uneven, and tho' angulated, yet quite inconsistently so, and the Angles usually blunted, as if by accidental Injuries. This had doubtless happened to them from rubbing against one another by the Motion of the Water ; nor is there any Doubt of their being the disunited Particles of some beautiful Stone lodged in the Strata of that Island.

## ESSAY V.

*On the strange Generation of a Species of Ichneumon Fly.*

THE Calmness of a Summer Evening having invited me to stay later than is customary among the Plants and Shrubs, Natives of foreign Climates, which the Genius and Industry of the best Manager of them in the World has made healthful Inhabitants of the Apothecaries Garden at *Chelsea*; I was called into one of the Quarters from a Walk at some Distance, by a strange fluttering of Wings which reached my Ear from a Shrub near its Centre. On approaching the little Tree I found it a very thriving Shoot of one which is a Native of *North America*, and which is supposed to be the same with that which in hotter Countries produces a medicinal Resin, intitled, *Taccamahacca*. I had often examined the viscous and fragrant Matter with which the Buds of this Tree are covered, even in our yet less favourable Climate, and found Reason to suppose that the Opinion of its elsewhere producing that Medicine was not erroneous: This was an old Observation, but the present Occasion of my contemplating it, a very new one.

There was just Light enough left of the Remains of Day for me to distinguish that the Noise I had heard was owing to a Number of large Butterflies, which were busily employed about its several Leaves.

I caught one of them without much disturbing the rest in their Employment ; on examining it I found it one of those Species which fly only in the Night, and which it is customary to distinguish by the Name of Moths. It was one of the largest and most beautiful of the *European* Kinds of these ; its Colours elegantly varied, its Antennæ beautifully ramose, and its Plumage large and distinct. I took it home, and was sorry that I had injured its Wings by the rude and unguarded way in which I had laid hold on it, and was eager for an Opportunity of coming at a more perfect Specimen.

I revisited the Shrub the next Evening, but in vain, not one came near it : A few Days after, however, I at once understood the Nature of their Business about it, and had a Prospect of procuring what I wanted. On casually turning up one of the fairest Leaves, I found its under Surface in a Manner covered with little pellucid, round, and green Bodies : Many other of the Leaves were on Examination found to be furnished in the same Manner with these Bodies, which, without the previous Observation of the Moths having been about the Tree, any one at all acquainted with natural Subjects would have known to be the Eggs of some of the Butterfly Kind.

There was indeed a Circumstance in this that strangely surpris'd me : Nature has been so provident for all these helpless Animals, that the parent Butterfly, as if foreseeing what would be the Produce of her Egg, a devouring Worm, a Creature wholly unlike herself, prepares for its Support. It is singular that there are peculiar Species of Trees  
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and Plants, on which, and no other, the Caterpillar Tribe will feed. The Species which eats the Lime Leaf will starve upon the Elder, nor will that which we find upon Fennel eat the Rose-bush; Each has its appropriate Food; and tho' the parent Animal eats not at all herself, nor has perhaps, as is the case in many, even any Apparatus of Organs for it, she is guided by Instinct to deposit her Eggs on that peculiar Shrub or Plant alone, the Leaves of which will be Food for her Young.

It raises our Admiration to see this Conduct punctually and invariably followed, nor ever to meet with a single Creature of this Kind on any but the appropriate Stalk. Here however was a Thing more wonderful; we well know that in the several Species of the same Genus which resemble one another almost in all Respects, the Leaves are so similar that 'tis all one on which of several the Eggs are deposited: Thus as the Caterpillars of the Willow will feed on one Species of Willow as well as another, we see the Eggs of the same Butterfly laid on the Leaves of the several broad leaved or narrower leaved kind, tho' we never meet with them on the Poplar, the Maple, or the Elm. But here was a Shrub, the Genus of which we are hitherto ourselves ignorant of, brought over to us in Shoots and Twigs, which tho' they grow, have never flowered with us, a Native of a distant Climate, a Tree unknown till within a few Years among us, even in its external Form. How is it then that the parent Animal in this Species has singled it out for the Receptacle of her Eggs? How is it possible she should know to what Family it belongs, or whether

ther its Leaves will be Food for her Young? I had too high an Opinion of Instinct to be in doubt about the Consequences, tho' the Proof appeared so strange. The Willow is the natural and proper Food of this Caterpillar with us, but the Moth is also a Native of *America*, and its Caterpillar there feed on the Leaves of this Tree. That Instinct therefore which guides the Birds of the same Species in the most distant Places to chuse the same Materials, and dispose them in the same Form and Manner in the building their Nests, that Instinct which is to these humbler Creatures in the Place of Reason, and is incapable of Error, and is the same in all, prompted this Moth, tho' the Offspring of a Caterpillar fed on Willow, tho' bred where the Willow was abundantly plentiful, to deposit her Eggs on the new Shrub, and leave them in full Security.

The Rule which guides these Creatures never fails or errs. The Eggs lay their appointed Time upon the Leaf, and then produced their Young. I watched the little ones from the Diameter of the Head of a Pin to their full Growth, in which they were equal almost to ones little Finger in Length and Thickness. The Care of the Shrub had prompted the Gardener to have most of them destroyed, but at my Request some few were spared to grow to their full Period and pass their proper Changes.

As I was one Afternoon watching their Manner of feeding, I was Witness to an Assault made upon one of the Family of a very extraordinary Kind, and by an Insect very inconsiderable in Appearance

in Proportion to it. The Caterpillar was at this Time at its full Growth, its Head of a very formidable Look and its Tail armed with a large and pointed Protuberance, having the Appearance of a Sting. The Caterpillar was rolling its large Form about upon the upper Side of a Leaf, and seeming to bask in the Sun when the Enemy approached. This was no more than a little Fly, of that Kind called by Writers on Insects, it would not be easy to say why, the Ichneumenon, its Body was not of half the Thickness of a common blue Flesh-fly, about equal to twice its Length, and its whole Form tender and delicate to Admiration. It made a little Buzzing with its Wings as it approached, and I could perceive the Caterpillar twist and roll its hinder Part about at the Sound, as if sensible of some approaching Danger. Many Efforts were made to prevent it; but at length after having pitched upon the proper Place, the Fly alighted on the Body of the Caterpillar, and immediately raising its hinder-part aloft, and pointing downward the Extremity of it, which was armed with something resembling a Sting, it darted it with Violence against the Back of the Caterpillar.

I could distinguish that the sharp Body was plunged to its Base into the Flesh of the Creature. The Fly kept it there some Moments, and as soon as it had drawn it forth again, darted it down in the same Manner on another Part of the Creature's Body. I saw this repeated more than fifty Times, and a new Place chosen for every Wound: At length the Fly clapped its Wings together several Times, as if in Triumph, and made off unhurt. If the Caterpillar



pillar had shewed Terror on the Approach of the Enemy, the Anguish it expressed at the repeated Wounds seemed intolerable; at every Stroke it wreathed and twisted its whole Frame about, sometimes endeavouring to disengage itself by shaking off the Enemy, and sometimes aiming its Mouth or its pointless Sting toward the Place. It was all in vain, the little, tho' cruel, Tormentor kept its Place, and seemed to defy all the Attempts of the unweildy Enemy to dislodge or hurt it. I was shocked, but I was more surpris'd at the Sight. I could conceive no Reason, no End in in the Cruelty. I knew the brute Creation never destroy or hurt one another, unless some Benefit to themselves give the Temptation. I had thought Man, of all living Creatures, the only one that hurt his Fellow in mere Wantonness: I imagined here was an Exception; but conscious of the manifold Provisions of Nature, and of the obscure Ends of many of her Actions, I determin'd to suspend my Thoughts till I had seen farther.

An Hour more of Observation shewed me a Number of Flies of the same Kind, brought thither as if by the boasted Success of the former, to the same cruel Sport. I had suffered the Mischief to one of the Creatures, that I might have an Opportunity of seeing its Event. Mercy would not suffer me to be a Witness to any more of it, I killed several of the Flies in their Attempt, and on going home took with me the Caterpillar that I had seen so severely treated, and a Quantity of Leaves for its Support with me, to the Time of its Change for the winged State. I also took home the  
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Victims of my Resentment in the same Box. It was Business of some Time to see the Event of the cruel Attack upon the Caterpillar: I ordered a fresh Supply of the Leaves to be brought to me from Time to Time: It recovered to all Appearance the numerous Wounds it had received in a few Hours, and from that Time, for the Space of four or five Days, lived very comfortably in the Box, feeding more voraciously than ever on the Leaves which I gave it.

In the mean-time I was curious to examine the Structure of this pointed Body in the Fly which had the Appearance of a Sting, and which I had seen struck with so much Pain into the Flesh of the Caterpillar. On opening several of the Flies that I had brought away, I found they were all Females; all were full of Eggs, and the Organ at the Extremity of the Body, which had the Appearance of a Sting, was hollow, had a Communication with the Ovaries; and was indeed the Part thro' which the Eggs were laid. On pressing the Body of the Creature, I could at any Time, squeeze several thro' it.

What had appeared at first an Act of wanton Cruelty in the Fly, now presented itself in a new Light: The Cruelty indeed did not appear any less, but the Intent of the Action was evident: It was plain that the Wounds were not given in Sport, but that they were the Means of laying the Eggs; and nothing could be more evident than that an Egg had been left in every Wound.

There appeared a strange Cruelty in the Disposition of Nature, that the Eggs of one Animal were to be hatched in the very Flesh of another;

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yet the Thing seemed evident, and future Observation confirmed it in full Force. I observed the Caterpillar narrowly from Time to Time, and I could perceive that the Ease in which she passed the two first Days after the Wounds from the Fly, did not last over the third. She was from this Time to that of her ceasing to feed or move, in the most violent Agitations: A thousand Contortions of Body in a Moment shewed her Uneasiness and Anguish, and on examining her nicely with magnifying Glasses, I could at any Time during the last Day and half, distinguish the Motion of living Animals under her Skin.

On the Evening of the fifth Day the Creature ceased to eat, and in the Morning of the sixth seemed to be taking the Measures for spinning the Web, under which it was to change into the Chrysalis State, and from thence into that of the Butterfly; but Nature did not give it the Trouble of the Means to an End that could not be answered. It died during the first Attempts toward this.

Before the Death of the Caterpillar, there were abundant Proofs of the Truth of my Suspicion of of the Fly's having laid her Eggs in its Body, and of the Observation of their Produce moving under the Skin. Upon the Evening of the fifth and the Morning of the sixth Day after my taking it home, a Number of the Creatures hatched from the Fly's Eggs, and which had hitherto lived in the Body of the Caterpillar, made their Way out by a yet more painful Operation than that by which they were let in. They gnawed their own Passage thro' several Parts of the Back and Sides of the Creature,

and often made Wounds much larger than were necessary for their Exclusion. Soon after the Death of the unhappy Creature the rest all made their Way out in the same Manner.

Tho' I had been at some Pains to procure Food for the Caterpillar, there was none necessary on account of these; they had already fed sufficiently, and were arrived at the Time of their Changes. The winged Insects are never produced from the Egg in their proper Form, they are all hatched in the reptile State of Worms, Maggots or Caterpillars; and after feeding plentifully for a Time in that State, they undergo under the Cover and Defence of some kind or Web, or Shell, or Case, of some sort or other, a Change into the State of an Aurelia or Chrysalis, and thence issue all at once in their full Bigness and all their Glory in their winged Form.

The Worms hatched from the Eggs of this Fly were white, oblong, and their Bodies annulated or jointed. They had arrived at their full Growth on the very Day of the Death of the Caterpillar, and as the Body of that Creature, tho' a very proper Place for nourishing them, was not so for their passing thro' their several Changes, they had eaten their Way out in their full Perfection, and were now preparing for their Metamorphosis. They were no sooner out of their Confinement than they began to spin the Webs in which they were to pass the Period of their Rest: Each covered itself up in a beautiful Case of yellow Silk, and nothing more of Consequence passed that could be seen till they made their Way out in Form of the parent Animal,

to whose Eggs lodged in the Body of the Caterpillar they had owed their Origin. I fixed down several of these with small Pins to the Sides and Bottom of the Box while in their utmost Perfection, that I might examine their Forms with the greater Accuracy, and as an Observation of this kind never fails to repay the Pains it costs in the Beauties it discovers, I had now an Opportunity in the observing these little Creatures in this their most perfect State and unfulled Beauty, of seeing what surpris'd me.

We are apt to pass over the lesser Objects that occur to us either with an utter Neglect, or at best we give them but a casual Regard, not sufficient to discover that they have Singularity enough to demand a more particular Inspection. The Head of this beautiful Creature is round, prominent and large in Proportion to the Body: Its general Colour is Black, but just in the Centre of the Forehead there is a large and elegant Spot of Snow-white exactly of a triangular Figure; this appears elevated about the rest of the Surface, but it is not so in reality; the Brightness of the Colour only, and the Shadowing about it are occasioning the Deception, in the same Manner that it is done in Painting in those Figures or Parts of the Picture which appear to come forward out at the Canvas. On each Side of the Head stands a large Protuberance of a hemispheric Figure; these, tho' apparently so disproportioned to the Size, are the Eyes of the Creature; they are together more than equal in Bigness to the rest of the Head, and before the Microscope they make a very beautiful Appearance: Their Surface is not even, but cut into a

Multitude of little Planes like the Facets upon a Rose Diamond, and its Lustre is little inferior to that of that Gem. The Ground Colour of these Eyes seems to be a blackish Brown, but there is a Shade of a most elegant changeable Colour thrown over them; this is partly Purple, partly Green, and partly of that brassy Hue which is seen on the Backs of some of our Flies and Beetles, and is not equalled by any other Production either of Art or Nature.

Each of these Planes or Facets has in itself all the Uses, Powers and Properties, of an Eye, and is singly a complete Organ of Vision; so that what appear to be only two Eyes in the Head of this Creature and in many others of the Fly kind, are in reality each a Congeries of a vast Quantity of distinct ones.

Around the Edges of the triangular Spot of White, which adorns the Centre of the Forehead, there stand three little prominent round Bodies of a deep Black. The Brightness of these, above the rest of the Surface, distinguishes them, tho' they are in themselves extremely minute: These also are Eyes, but of a different Kind, and formed to different Purposes from those of the other: As those numerous ones are in Effect so many minute Lenses seeing only at the smallest Distance, and serving to point out the Creature's Food, and to other such Purposes in which only Objects almost in Contact are concerned, these other three, each of which is a single Eye and considerably larger than the separate ones of the others, sees to a greater Distance, and  
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gives the Creature Warning of the Approach of Danger, or the Appearance of its Mate.

We are apt to suppose Nature has lavished all her Bounty upon her larger Creatures, and left these Minims of Existence, as *Shakespear* phrases it, unfinished, and scarce half made up. With how different an Idea must they be struck on seeing an Apparatus for Vision so infinitely more complete, so evidently superior both in its Structure and Purposes, to that allowed to the Lords of the Creation, bestowed upon this little Fly: But the Sight is not all in which it so amazingly excels us. Between the Eyes there stand two long and slender Bodies of beautiful Form, and the most delicate Structure; these the Vulgar call Horns, the Writers on these Subjects *Antennæ*. We do not even know for what Purposes they are ordained, but their Structure shews they could not have been given in vain; perhaps they are the Organs of Hearing, perhaps of Smelling, perhaps of a peculiar Feeling, more delicate than our own, and sensible even to the least Emotions or Disturbances in the ambient Fluid: Possibly for some Sense, itself, even unknown to the gross Organs of our boasted Frame. Be what it will, their Use however, their Form is worthy our highest Admiration: Each of them is equal to two thirds of the Length of the Body, and not so thick as the finest Hair; to the naked Eye they appear meer Filaments, but to the more accurate Inspection of the Microscope, each is found to be of an articulated or jointed Structure.

Each of them is composed of fifteen Joints, these are all of the same Length, the same Diameter, and

the same Figure: Each is of the Form of a Segment of a Cylinder, its Length equal to about twice and a half its Diameter. They are all truncated at each End, where they are joined to the preceding and following Joint; and all have their Surface, not smooth and even, as it appears to the naked Eye, but channeled with a vast Number of longitudinal Furrows, in the Manner of the fluted Columns in Architecture. The Structure of these Parts of the Insect Tribe (for they are universal to that Class of Animals) has not been sufficiently known; what I observed in the Examination of these with Glasses of greatly more than common Power, may serve as a Step toward discovering their Use. I found in the Surface of each Furrow three distinct Rows of Apertures or minute Holes; one of these Series ran exactly along the Centre of the Furrow, and another at some little Distance on each Side of it. These were not all of the same Diameter, but those at the Top were evidently largest, and from thence they became gradually smaller to the Bottom of each Series.

The general Colour of these Antennæ is a deep Black, but as there is a Spot of White in the Centre of the Forehead, so there is the Appearance of a Circle or Ring of the same Colour, surrounding the Middle of each of these: This gives a very pretty Variegation to the Appearance, but when nearly examined, it is not found to be a Spot as it appears; but it is the middle Joint of each Antennæ that is of this Snow-white, with seven black above and as many of the same Colour below it.



The Breast is of an extremely elegant Colour; it is pale, and would be of a pearly White, for there is evidently something bluish in it; but that there is an over-bearing Cast of a pale Red, so that the whole is in some Degree Flesh Colour; or, to express it by the only Allusion that can be made to it with Propriety, it is exactly of that Colour which we sometimes see in the Milk Sapphire, when tinged with an adventitious pink Colour. The upper Part of this is somewhat whiter, and the Sides have more of blueish Red than the rest; but on each Side there are also three little round Spots of a more pearly or blueish Tinge than any Part of the Surface.

The Body is of a very beautiful Colour, a bright Green with a brassy yellow Shining thro' it, in the Manner of the two Colours in the changeable Silks; and the whole is very bright and glossy. The Body in this, as in other Insects, is divided by circular Rings, into a Number of Joints; and what adds vastly to the Beauty of the Creature is that all these Rings are of a high Scarlet; and the last Joint of the Body, or, as it is usually called, the Tail, is also entirely of the same high and fine Scarlet. Along each Side of the Body also there is a Series of small round and elegant Spots, of the same bright Colour, but, if any thing, somewhat paler than the Tail or the Rings: The Belly has more of Green, but less of the brassy Tinge.

The Legs are long and slender, and are not at all inferior to the other Parts of the Insect in the Beauty and Elegance of their Structure. Their

Colour is Scarlet, but not that high and pure Scarlet which paints the Tail or last Joint of the Body; these have more of an Orange Tinge with the Red, and the Beauty of the Colour is hardly the less for it. It is not easy indeed to conceive a brighter Colour than that of the last Joint of the Body of this Insect; the circular Rings above, on the Body, tho' very elegant, are less so than this, and the Colouring of the Legs differs from both in its Admixture of Yellow.

• The upper Joint of each Leg is thick and of an angulated Figure; there run several Ridges along it, and on the Top of each is a Series of short black Bristles. The Plains or Hollows between these Ridges are smooth, but the Hairs being very obvious and evident on them, give an Appearance of Hairiness to the whole, and make a very beautiful Shade in the Colouring. The lower Joints are much slenderer, and are also an angulated Form, and hairy in the same Manner. The Bottom of each Leg is terminated by a Foot of very singular Structure; it is composed of three Toes, two anterior and one posterior; and between these there is lodged a roundish Body of a spongy Structure, serving as a Kind of Soal. The Claws are all three very slender, and of a coal-black Colour; the two anterior ones are long, the hinder one short. The spongy Matter in the Middle is of a dusky or brownish Orange Colour, and seems capable of Contraction by Means of the drawing the Toes together at the Pleasure of the Animal.

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Thus far all the several Individuals which I had examined agreed in every Particular, but it was singular that there appeared a great Difference in the Appendages to the last Joint of the Body of the different ones. It may be remembered that in the Description of the parent Animal, to whose Eggs all this Progeny owed their Existence, I observed a Weapon at the Extremity of the Body in Form resembling a Sting, which the Insect at times plunged deep into the Flesh of the Caterpillar. Many of the Creatures now under Examination had this in exactly the same Form and Dimensions with that, but others, nearly in an equal Number, had it scarce visible from its shortness; and as this was the sole Appendage to the Tail of those, these on the contrary had each of them three long rigid and slender Hairs, growing above what appeared the Rudiment of it, and equal to the whole Body in Length. These were of the same Colour with the Antennæ, a deep Black, but they had no Variegations; and when closely examined by Means of the Microscope, they are found to be as those to the naked Eye appear, simple Filaments, not articulated, hollow and pierced, in the elegant and regular Manner in which they are.

A little Observation shewed me, that this Difference in the Structure of the hinder Part of the Body distinguished the Sexes. Those which had the three Hairs at the Tail were all Males, and those which had the Weapon longer, and had none of these Appendages, were the Females.

The Wings were the only Part of the Creature that now remained to be examined, and these, tho' to a common Observer they might appear of no singular Structure, carried the Promise of something that might repay the Trouble of Examination. The naked Eye could discover that they were not mere Membrances, tho' on a cursory Look they might have appeared little more than such.

The Number of the Wings is four: They are form'd into two Pairs, an outer and an inner; but they are very nearly of the same Size, and scarce at all different in Form and external Appearance. The outer Pair are a little larger than the inner, and the latter are of a somewhat darker Colour than those. They are all bright, clear, and transparent. They seem formed each of a simple Membrane of peculiar Thinness and Delicacy, and their Colour is a pale Brown; but they are each of them edged with a surrounding Line of deeper Brown, and spotted near the exterior Rim with round and moderately large Spots of the same Colour.

The Assistance of a very moderate Magnifier shewed them edged with a kind of Hairyness on the outer Verge, and that they were supported by Ribs, along the Ridges of which there ran also a Hairyness of the same Kind.

On applying a Magnifier of the necessary Power, it appeared that each Wing was composed not of one, but of two distinct Membrances, between which were lodged the Ribs or Nerves which supported them.

them. The Membranes themselves appeared of the Colour of dirty Parchment, and scarce more transparent; they were spotted all over with little round Dots, of a somewhat duskyer Colour than the Ground; and the Line on the Verge was found to be formed only of a close Series of the same Spots, but larger; and the simple round Dots, visible to the naked Eye, were also the same with these.

The Ribs were divaricated into several Branches, and their Prominence was easily distinguished between the Membranes. The Hairyness, as it had appeared to the Magnifier of less Power, was now discovered to consist of regular Bodies, of a pyramidal Form, and affixed by their Bases to the Edge and to the other Parts of the Membranes, and capable of Motion independently of the rest of the Wing. While the Fly whose Wing was thus examined remained alive, I had the Opportunity of seeing these change their Situation several Times; tho' that was kept firm between the Points of the Forceps, they were frequently all erected, and often depressed quite to a Flatness with the rest of the Wing, tho' their natural Position of Rest seems between these Extreams. What I farther observed was, that they seemed capable only of the same Motion all together, no Instance offering of any of them changing its Position independantly of the rest.

Of the several Individuals which were produced from the Chrysalises of the Worms, which had eaten their Way out of the Body of the Caterpillar, some died

died in the Place where they were excluded, others flew about the Room; and the Males, almost upon the Instant of their Production in this perfect State, fought out and impregnated the Females, after which they appeared languid, and lived but a very short Time. Of the Females thus put into a State of perpetuating their Species, not one made any Attempt to deposit their Eggs with me, for want of the proper Nidus, the singular Destination of Nature for the Preservation and Food of the Young.

'Tis a very surprising Thing in this Instance of the Provision for an Animal by the Means of another, that the Worms, tho' they evidently feed on the Juices drawn by the Caterpillar from its Food, yet never erode the vital Parts of that Animal, but feed in so careful a Manner as not to destroy the Creature at whose Expence they are supported.



## E S S A Y VI.

*Of a peculiar and undescribed Microscopic-Insect produced in the Infusion of a vegetable Substance.*

THE Appearance of Animals of various Kinds in putrefied animal and vegetable Substances, and the Production of the lesser Animalcules discoverable only by the Microscope from Infusions of either in Water, was the Subject of an Hour's Conversation some Years since, with that Patron and Ornament of the Sciences, the late Lord *Petre*. The Observation of *Redi*, that the Maggots found in stinking Meat were owing to the Eggs of Flies deposited there, and that the excluding them, by tying a Piece of Cambric over the Vessel in which the Meat was put, would make it stink without any, was mentioned; and as his Lordship had just been reading some of the *French* as well as *English* Accounts of the Microscopical Animals produced in the Water in which Vegetables had been infused, and had read that every Plant, in such an Infusion, produced a different Insect, he was induced to believe, that whatever might be the Occasion of the larger Species in decaying animal Substances, these more minute ones must, as they constantly appeared from all, and differed in each, be the absolute Effect of the Decomposition of the Vegetable itself; and not owe their Origin to animal Parents of the same Kind.

It is but Justice to the Memory of this truly great Man to acknowledge, that this was the first Hint I ever heard of a System that has since been much cultivated by the *French*, and by a very ingenious *Englishman* residing among those curious, but too hasty Naturalists. Ingenious as that System appears, and with all that seems to support it, I think on a proper Occasion it may not be difficult to prove, that its Conclusions are erroneous. Be that as it will, however, the Thought gave Occasion to some Experiments that amply paid the Trouble of making them. We were in the Garden when the Subject was started, and as it was determined to make, with some Degree of Accuracy, the necessary Trials, I collected as we passed thro' the several Walks, the Seeds of a considerable Number of Plants, and the Leaves of some others, and these I selected out of such as were least likely to give Birth to Animals at all, or most suited to destroy them.

The Organs and Tastes of the Insect Kind are, however, so different from those of the larger Animals, that I made no Conclusion from this: I observed to his Lordship, that Worms would feed upon the Galangal and Pyrethrum, and other Drugs in the Shops, the Taste of which was so hot and acrimonious, that we could not bear them in our Mouths; and that Jalap, which proves so coarse and violent a Cathartic to us, feeds Multitudes of them, with no such Effect. From these, and many similar Instances, I inferred that the Seeds of the most poisonous Plants would not fail to produce  
Insects



Insects as plentifully as those of the most innocent ; and the Event answered the Expectation.

The several Materials were bruised separately, and each, after this Operation, divided into two Parcels ; these were put into two separate Gally-pots, and a sufficient Quantity of Water, about twelve times their own Weight, was poured on each. Of the two Gally-pots which contained the same Matter, the one was always left open, the other was tyed firmly over with a wet Bladder ; and after marking them with the Names of the Plant they contained, the whole Parcel were set in a Window of a large Room, where the Sun did not come at any Part of the Day, and where there was no Fire.

The Observation, that every Vegetable produces a different Animalcule, we found to be false. There were more than thirty Infusions of different Plants in Pairs in this Window, but on examining them at a Time when they were full of Life, the Species of Animals in them were not more than eight. It was observable also, that among this Variety the several Plants which belonged to the same Genus, or which were most alike in their Qualities and Tastes, produced the same Species ; those which were unlike in these Respects, different ones. The Leaves of the Anemone and Ranunculus afforded the same Insect, but this was perfectly different from that produced by the Seeds of Parsly and Carrots ; and the same Species appeared in the Infusions of the Aster and Chrysanthemummer, but it was perfectly different from that found in the Water in which the Leaves of Purslain had been steeped.

steeped. We looked with great Care to find the Creature, on whose Back a certain *French* Writer says there is the Figure of a Satyr's Face, and which he declares he met with in an Infusion of the Anemone, but we found nothing so extraordinary there. As among the Plants which had afforded the Subjects for these Observations, I had selected many others, the same with those on which that Author made his Observations, and from the Creatures pretended to be found in the Infusions of which he has caused his Figure to be engraved, we had Opportunity to see that this Satyr Animal was not the single Instance in which that flighty Writer has trifled with himself and the World, and feigned and described Animals which never existed any where but in his own Imagination. These are the Authors who give the most fatal Wound to natural History, and they ought not to pass uncensured. The Man of a curious Disposition, who is led to repeat the Experiments of Writers on this most curious and interesting Subject, if he finds the first two or three that he attempts not succeed according to the Account, condemns the whole as the Work of Fancy not of Observation, and construes that into an Affront upon the Creator, which is an Act of Praise. It would be enough to deter People from the Use of the Microscope, to enumerate the Falsities that have been advanced by Authors who have written on the Subject. Even *Lewenboeck* the Father, as he may be called, of this Branch of Observation, is not without his Mistakes, tho' there are many more in Proportion in all that have followed him. In general, the

*French*

*French* are fuller of Error than the *English*; and what is more to the Credit of our own Writers is, that the Mistakes of their Observations are from false Views, bad Lights, or the Imperfections of their Apparatus, and that they have almost universally done their best in the Way to Truth; whereas many of the false Accounts of the *French* Writers were known to be such by the People who advanced them, and had their Origin more in a Fondness for telling something strange and surprising, than for any real Error in the Observation.

Thus much in regard to the Accounts of microscopical Observations, from one who has with almost too much Patience gone thro' the several Processes, may serve to set the Matter itself in a true Light, to give the Honour due to the philosophic Genius of our own Nation, to caution against the too implicit Faith that might be placed in the Relations of those of a Country fond of Miracles, and to encourage the Person who sets out even unluckily in these Studies to prosecute them in Defiance of a few Miscarriages. The several Parts of the single Apparatus for Observation, which has been mentioned in the setting out of this Essay, afforded Variety and Curiosity of Matter enough to encourage any who saw it, to go on experimenting on his own Foundation, even tho' all the Authors in the World had written falsely.

The greater Part of the Animalcules produced in these several Infusions, tho' full of sufficient Matter of Admiration, were such as have been on other Occasions described by those who have before written on these Subjects; and as it is not the In-

tent of these Effays to new dress up old Matter for those who are less acquainted with the Subject; but to furnish from original Observations that which must be new even to the most conversant with it, I shall make no mention of these. The Occasion of this Effay was an Animalcule unknown, or if it have been seen in the Gross, wholly unobserved as to its Organs, Parts and Faculties; and which has enough of Singularity about it to attract the Attention of any body; and so much that, if it have been seen, it is a surprising Thing that it has not been described.

Among the Seeds which were put into Water on this Occasion, there were those of the Stramonium or Thorn Apple, of Tobacco, and of the Lycopersicon. We examined these from Day to Day, and on the two first found nothing. The Water was foul, and there seemed an intestine Motion like that of Fermentation in it: On the Morning of the third Day the separated Particles of the Seeds which, while suspended in the Fluid, had rendered it turbid, were subsided to the Bottom; the Liquor was clear, and on examining a Drop of it before the Microscope, we found it full of Animalcules. On opening the Pots which had been tyed down with Bladder, we found Matters in the same Situation without the least Difference, the Water was as clear, the whole Matter of the bruised Seeds was as regularly fallen to the Bottom, and every Drop was as fully peopled with Life as in the other. We tyed over these again, and proceeded on the Examination with the other, or open Gally-pots.

On

On the most careful Examination we found that the Animalcules in the Infusions of these three Seeds were the same; they were very numerous in all, but in particular in that of the Stramonium they were so crowded, that they appeared to have scarce Room for their Motions, and were continually running over one another's Backs. It was necessary to separate them by adding fresh Water to the Drop laid on the Plate of Glass before the Microscope, in order to distinguish their Structure. They were very nimble in their Motions, they appeared all of the same Size and Form, and tho' continually rolling over one another, they seemed not to do, nor intend, one another any Harm.

The double Microscope is the proper one for these Observations, and the Time for making them to most Advantage is when the Drop of Water, in which there are but few of them, is almost evaporated: In their common State in the native Fluid, their Number confounds the Observer; and when separated by the Addition of clear Water, their Motions are at first so swift, that there is no forming a regular Judgment of any thing about them. After a great many Trials I succeeded so as to have only about half a Dozen of them in a considerably larger Drop before the Microscope; and as they began to be sickened by the strong Light thrown upon them from the Reflector, and the Water to dry away, their Motions became less violent, and their Forms more distinguishable; I seized the Opportunity of one of them that had straggled into a Corner from the rest, and continued my Observations solely on that.

It was of the larger Kind of Microscopic-Animals, tho' by many Degrees too small to be visible to the naked Eye. Its Form was elliptic, but somewhat tending to oval; one of the Extremities, tho' both were rounded and obtuse, being somewhat smaller than the other. Its Body was depressed or flatted, and that equally throughout; it was so transparent, that the Form of the Intestines, and even their Motions, might be discovered thro' it; and it was surrounded with a Kind of Fibrills all round the Edge, resembling Hairs; these were almost continually kept in an undulatory Motion. They seemed to assist in the poising the Body of the Creature, rather than in its Progressions; for those appeared to be performed by the Bendings of its Body, when violent; and when more slow, by some Apparatus in the under Part, not discoverable in this Position.

The Glasses which had served to give this View of the whole Animal, were by no means equal to the Business of investigating its minuter Parts. I adapted a Magnifier of much greater Power, and while the Area taken in at a View was not equal to a fifth Part of the Diameter of the Body, had Opportunity of acquainting myself very accurately with the little Portion that was seen.

The Skin of this minute Creature was now discovered to be not smooth and glossy, as are many of the lesser Animals, but granulated exactly in the Manner of our Shagrine Leather, or the Skin of some of the Sea Fish; with a sharp Point to every Granulation: These prominent Parts, or pointed Granulations, were of a Colour much paler than  
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the rest of the Surface; they appeared semi-pellucid and whitish, the rest less transparent, and of an Olive Brown. What an Armature this for the Skin of so minute a Creature, and so far as it was possible to see in this Observation, how unnecessary. The Spins of the Hedge-Hog, and these Points were of the same Kind in Proportion, are meant for its Defence against Animals that would otherwise devour it. We should not make out the Use of these indeed, if we were to find the Creature in a Country inhabited by no other Animals; and tho' in this Place the Insect under Consideration has no Enemies to fear, it is not appropriated to this single Fluid, and in others it may have devouring Concomitants, against whom all this Apparatus of Defence may be necessary.

From the Examination of the Skin we proceeded to that of the Fibrills at the Edge of the Body: It was not without Foundation that I had suspected these to be of Use to the Creature, in the Manner of Fins; tho' they had appeared simple Filaments or Hairs to a less powerful Set of Glasses, they were now found to be Fins, each composed of a flat Body, broader at the Base and growing gradually smaller to the Extremity, where it divided into two Parts, and all the Way furnished on each Side with Series of shorter Fibres, placed in the Manner of the Plumage of Birds. Toward the smaller Part of the Animal, which by its being always carried foremost in its Motions appeared to be the Head, they were short and inconsiderable, all the Way toward the other Extremity they became gradually longer and longer; and, in fine,

at the very End, or in the Centre of the broadest Extremity of the Animal, there stood three which were considerably longer than the rest: These were not all of the same Length, but the middle one longer than the other two: They were broader as well as longer than the others, and were so placed, that their Fibrills at the Sides joined one another. The whole Assemblage thus seemed to form only one regular Fin, and this probably serves as a Tail to the Animal.

The Water dry'd quite away, and the Animal died during this Observation. I took the usual Method of turning the Glass to see the under Part of the Creature, but found a thinner Substance necessary in order to see with any Degree of Accuracy what I was eager to be well ascertained about, as the under Part seemed to promise much more than the upper in this Creature.

I now slit off an extremely fine Plate of *Muscovy* Talc, or, as it is usually called, Isinglass, for the holding the Animal of the next Observation. It was not till after several ineffectual Trials that we succeeded in getting one of the Animalcules again separated from its Company, and in a Condition for accurate Examination. Very happily, however, a single Drop of Water, into which the minutest Portion imaginable of the impregnated Fluid had been dropped from the Tip of a Camel's Hair Pencil, afforded no less than three of them together. We had now great Opportunities before the Water began to dry away, of viewing them in Motion, by Means of a small magnifying Power, which consequently took in a larger Area. We

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could



could distinguish that all the Motion was not swimming, but that there was some walking on the Bottom, which we had before mistaken for the other Motion. It was easy to see by the undulatory Convulsions of the Body during this slower Motion, that it was performed by Means of numerous Legs; and a very lucky Incident gave us an Opportunity of seeing yet a third Use of its Limbs, which was in climbing. A small Filament from the End of the Pencil had come off with the Animals into the Liquor, and stood assant, one End of it being fixed, or at least applied, to the Talc, and the other reaching nearly to the Surface of the Liquor. We saw one of the Animalcules as it came up to this, apply its Belly lengthwise to it, and instantly climb to its Top and down again. This it did several Times successively with great Facility, and so minute was it that it never moved the Hair, which had so very little to keep it in its Direction.

The Motion which these Creatures had in the Mid-water, and which to distinguish it from their creeping and climbing, must be called swimming, tho' not perhaps with perfect Propriety, was performed much more swiftly than either of the others; and the Creature rolled itself about during its Course in a surprising Manner, turning often over and over, crossing, running the Length of the Drop and back again, as if in sport, and with a surprising Rapidity.

When our Attention had been some Time employ'd upon this, the drying up of the Drop of Water in which all these Journeys had been taken, gave

us the Signal for adapting Glasses of more Power for the Examination of the Parts of the Animal on its Belly, or the under Side of its Body. When these were put on, and the Piece of Talc with the Animals, and the Remains of the Drop of Water on it, we had the good Fortune to find Things in a Situation for Examination, and the Creatures not quite dead: The small Remains of the Fluid just kept them alive and their Limbs in Motion, without separating them from their Contact with the Talc.

The first Discovery we made was, that the Creature had indeed Legs, such as they were, in great Number; there were no less than eight Rows of them. These were placed longitudinally from the Head to the Tail, at regular Distances from one another, the middle Series very near the Centre of the Creature, and the extream ones but at a small Distance from the Fins which edged the Sides: Each Series consisted of an almost infinite Number of Legs; these were very small and short, but each was divided into two Toes or Portions at the Extremity. The Creature occasionally moved any Number of these; sometimes we saw a whole Series or more in Motion at once, sometimes only a few of several Series; and the most usual State of their Movement was that of about half a Dozen of every Series, quite across the Body in the same Line. This is undoubtedly the Manner in which the Creature walks, and as its swimming or Motion in Mid-Water is performed by the Motion of the hinder Part of the Body, and the Assistance of its Fringe of Fins, the Climbing which we had an

Opportunity of seeing by Means of the Hair, must have been owing to the two middle Rows of Legs, between which it certainly embraces slender Bodies of that Kind, on these Occasions.

Nothing was farther observable of the Legs; but toward the anterior Extremity we saw two oblong and jointed Bodies, quite different from either the Fins or the Legs of the Creature, which were frequently in Motion, rubbing their notched and dentated Sides against one another, and doubling themselves at the several Joints so as to approach with their Extremities the Surface of the Body. These Weapons on a closer Inspection appeared to have much the Form of the larger Claws of the Lobster kind: They were largest in the fourth or extrem Joint; and tho' at first we thought that Joint which formed the Extremity solid and intended as a Kind of Club, yet the convulsive Motions of one of these, as the Creature was expiring for want of a Supply of the Fluid, convinced us that they were forked, and formed for seizing any Thing that comes in their Way. It is on the Joint next under this that the Serratures or Indentings appear; this second Joint from the Extremity, or third, counting from the Body, is flat and dentated, in Manner of a Saw on both Edges; and on a closer Examination we could distinguish, that the whole inner Surface of it was rough in the Manner of a File, and covered with Points like those of the Back of the Animal, only shorter and less sharp. The other two Joints, or those nearest to the Body, were simple, uniform, and smooth; they served for nothing more than directing and moving the others.

A little below the Base or Infertion of these to the Body, there appeared a Mark of a femilunar Figure, with its Points upward and the convex Part toward the larger End or Tail of the Animal. This had hitherto seemed only a Mark or Line of a different Colour from the rest, but the same Circumstance which gave us an Opportunity of discovering that the Claws, if they may be so called, were forked at the End, explained also that this was the Mouth: We saw it open at several Times as the Creature was gasping in its last Agonies, and could not but observe that its Diameter was enormous in Proportion to the Bulk of the Animal.

Here then in so minute and inconsiderable a Creature we have discovered an Apparatus of Limbs more elaborately formed than those of the largest Animal. It was easy to conceive, that the Use of the singular Arms or Claws placed before the Mouth was for feeding; but the particular Manner in which they were to be employed, and even what was the destined Food, was yet to learn. Almost all the minute Animals discovered by Means of the Microscope, are carnivorous, and as where there is one Species of them there is usually also another, they feed on one another as the larger Animals. They are indeed, tho' all beneath the Discernment of the naked Eye, yet as different from one another in Size, as Hawks from Sparrows, or as those from Worms, and they feed on one another in Succession, as the Roach on the Water Insect, the Pike on the Roach, and so on. But here was an Animal that seemed destined to live alone, to roam about in Seas, where no  
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animated Inhabitant had Existence except itself. It is not to be doubted but Creatures, even below the minutest of those we see in the common Fluids, may have Existence there, and that Gradations infinite between those Atoms of Existence and nothing, may have Being. I have often thought that it is with our Microscopes in these little *Aræ* of Examination, as with our Telescopes in the vast Expanse of the Heavens; there, after the naked Eye has counted all the Stars its Organs can discover, the slightest Telescope shews more; and even in Spaces where there appear to that assistant Instrument no more, a greater Power of Magnifying will discover others, and so on, to all our Lengths of Improvements, and probably infinitely beyond them. Thus I am apt to believe it is with these Fluids, that where the naked Eye discovers nothing but a clear uninhabited Expanse, a little Power of magnifying shews one Series of Animals, a greater another, a greater yet a third Generation more minute than they, and so on, beyond all our Powers of encreasing the Faculty of Observation. An Imagination like this is founded on evident Principles, and it is placing the Works of the Creation in a Light that does Honour to our own Conceptions. But allowing all the Force of this, and supposing that there may be Animalcules of many Kinds in the same Fluid, with these comparatively larger, tho' not discoverable by all our Efforts, yet it will not answer the present Purpose. The Instruments of feeding are in all Creatures proportioned to the Nature of the Food, nor would Nature have allotted Organs of the Size of these  
Claws

Claws for the seizing upon Creatures too minute to be seen by the Glass, which were of Power to shew them so distinctly.

We were sufficiently acquainted with the Apparatus for feeding, it remained to be informed of the Manner in which they were used, and of the Nature of the Creatures Food. We tried many Things in vain for this Purpose. When the Animals were separated, as we usually had them for Observation, by Means of some additional Water, there never seemed an Attempt to use these Weapons; and when we saw them simply in their own Fluid, their Numbers and continual Motion made it impossible to distinguish any thing. An Accident at length led us to what we had been attempting so long in vain: A large Fragment of one of the bruised Seeds had been taken up in a Drop of the Fluid, and we saw the Animalcules all busy in Clusters about. We diluted the Drop with additional Water, and at length succeeded so well as to wash away all but two or three that were most busy. It now was too long before we saw the whole Process of the Creatures feeding, and the Use of that Apparatus which we had been before so well acquainted with as to Form.

We watched one of the busiest of the Animalcules till it was in such a Situation on the Side of the Fragment of the Seed, which many times exceeded its own Bulk, that we could distinguish all that passed, and the Reflector from below happily threw its Light directly upon and between the Body of the Animal and the Surface of the Fragment. By this lucky Incident, we were enabled to see every  
Motion

Motion and every Circumstance of the whole. The Creature was some Time in adjusting its Body to its new Position; it brought by degrees more and more of its Legs to bear; till at length by the bending of the necessary Parts of the Body to the Form of the Surface of the Seed, every Leg in every Series, so far as we could discover, touched the Surface; and in those which were nearest to us, we could see the Use of the divided Extremity; for the two Toes of each of these Legs, formed by that Division, were pressed close, and their Points seemed to enter into the very Surface of the Seed. It was not long before the Observation became more limited; the Fins of the Sides of the Body, applied themselves to the Surface of the Seed also; and the three peculiar ones, which I have before observed formed a kind of Tail, applied themselves to it so firmly, that all Passage of the Light into the Space, between the Belly of the Animal and the Surface of the Seed, was intercepted; and by degrees the same Thing happened all along the Sides by the equally close and firm Application of the Fins situated there.

The Animal, when its whole posterior Part was thus thoroughly fixed down, began to move the anterior Extremity: After several Vibrations, it fixed it in such a Position, that the Angle made by it with the Surface of the Seed, was open enough to discover its Mouth; and the Claws or Forceps, or by whatever other Name we call them, for they answered so many Purposes that it is not easy to express them all by one Word, began to work.

The first Thing we discovered, was the Use of the dentated Edge of the second Joint: We saw this instantly used with great Regularity in Manner of a Saw. The Creature soon worked off a Piece from the solid Fragment with this Edge of one of the Claws, and as it dropped off the Forceps, or open Part of the opposite Claw, seized it in its Descent toward the Bottom. This instantly conveyed it, not as I expected to the Mouth which was large enough to have very easily received it, but to the flat Surface of the second Joint of that Claw which had sawed it off. This Surface, as has been before observed, is notched in Manner of a File on both Claws: The Morsel easily stuck to this, and in an Instant the similar Surface of the second Joint of the other Claw was brought to bear upon it, and we saw them employed in a quick Motion of rubbing against one another, the Consequence of which, tho' we could not distinguish that, must have been the tearing the Morsel to Pieces, or grinding it down into a kind of Pulp.

A few Repetitions of this Motion seemed to do the Business; the Joints of the Claws immediately after doubled together, so as to bring this distant Part of them to the Mouth; the opening of that took in a whole Surface of one of the Joints at once, and after a little Time that was drawn out and the other put in its Place. The Motions by which all this was performed, were too swift to give us Leave to see that they went in loaded with the Pulp of the Seed, and came out empty, but it must certainly have been so; and the Use of this vast Expanse of Mouth, must be to receive these

Joints



Joints thus loaded with Food, for some Apparatus, to us wholly undistinguishable, to lick it off.

The other Claw was immediately after employed in the same Manner to saw off a Piece of the Seed, and this was seized before it fell by the Forceps of the opposite Claw, and delivered as the other to the grinding Part, and there treated as before. We saw this repeated several Times, and at length, when the Creature had satisfied its Appetite, we saw it with much less Ceremony, loosen its Body from the Seed than it had used in fixing it down: This indeed was done almost instantaneously, and the Creature swam away with great seeming Satisfaction.

Thus whatever farther Parallel there may be between the Production of Maggots in putrid animal Substances, and these Animalcules in vegetable Infusions, there is at least thus much, that the Matter in which we find them, affords Food for both; and it seems the Provision of Nature, by whatever different Means it may be executed, that wherever there is a proper Food for these several Tribes of Animals, there shall be the Animals to eat it, and enjoy there being among it.



## E S S A Y VII.

*On a peculiar and undescribed Plant of the Fungus Kind, appearing on the Surfaces of vegetable Infusions.*

**I**N the making the Preparations for the Subject of the preceeding *Essay*, I have observed, that there were Duplicates of the several Infusions, which were the Subject of our Investigations: The one always left open to the Access of the free Air, the other covered close as might be, by tying it down with a wetted Bladder. At the Time when the living Inhabitants were first discovered in the Liquor or open Vessel, that in the covered one had been also examined, and found equally peopled with its Inhabitants in all Respects the same with those of the other. Some Days had passed in the repeated Examinations of these singular Creatures: The Pot which had been opened, at the first Appearance of those in the other, had been immediately after tied down again, and had remained undisturbed. The Inhabitants of our open Vessel continued in all their Vigour; and we had the Curiosity to open the other again, to see whether those which had been thus confined had fared as well.

On opening the Pot, we were surpris'd very agreeably with a new Production, spreading its Beauties over the whole Surface of the Liquor. The Reader will be ready to smile on hearing that the whole of this Matter was, that the Liquor had  
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grown mouldy: But what the incurious Eye passes over as nothing, or confounds with a thousand other Ideas, under the Name of Putrefaction, the philosophic Observer investigates to the Depth, and he seldom fails to be rewarded by the Beauty or Singularity, for the Trouble of the Investigation.

What People, less acquainted with the Works of Nature, would have scummed off and thrown away, appeared to us the most estimable Part. The Inhabitants of that Fluid we had before thoroughly examined, here there was offered a new Field for Wonder. We just satisfied ourselves that the Creatures were yet living in the Fluid, and then proceeded to examine the new Production.

As the others had been of the animal Kingdom, this new Object was evidently of the vegetable: What it offered to the View, was a thin and smooth Crust of a greenish Colour, resembling a Piece of fine Leather, evenly extended over the Surface of the Matter, and from this a Number of little Pedicles, supporting small round Heads. These, at a first View, much resembled extremely minute Pins, struck into the common Matter that cover the Liquor.

I had been sufficiently used to Investigations of this Kind, to know that what we saw was worth Examination, but was not in the best Condition that might be for it: The Crust, I was sensible, was formed of a Congeries of Plants which had spoiled one another's Forms, by crowding together. I knew the sudden Growth of these minute Vegetables,

getables, and promised my noble Friend a full View of what we wished by the next Day, in a proper Form. We cut off about a third of the Crust, leaving so much of the Surface of the Liquor naked, and ordered the Covering of the Pot to be put on again.

The Progress of Nature in her vegetable Productions is in some Degree proportioned to their Size. While the Oak is, as Naturalists tell us, a hundred Years in coming to its full Growth, a hundred more in Perfection, and an equal Period in decaying; these little tender Things arrive from the very State of the Seed to their full Growth in about seven Hours, continue in their Perfection an Hour or two, and then fade, to make Room for their Progeny; the Shell or Crust at the Bottom only remaining for the Support of the young Brood. I had observed that every round Head which we saw upon the common Crust was fraught with ripening Seeds, all which must soon be disclosed, and that while such of them as fell immediately on the Crust would blend their Progeny with the rest, some would doubtless waft themselves to the naked Part of the Surface, and there give us distinct Plants in a Condition to be observed.

As I presaged it happened; on our uncovering the Pot the next Morning, the Part of the Surface of the Fluid which we had left vacant was spotted as it were with White, nor was it difficult to determine that every one of these Specks was one of the Plants which we wanted to examine.

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To the naked Eye these seemed mere simple Dots, of a white Colour, not equal to a third of the Diameter of the smallest Pin's Head, but on applying an Apparatus of a moderate Power to view them, we could distinguish that each was a round, [or nearly round] Crust, with a Number of little Points arising from it. The Plants were yet at a very early Period, they had not acquired their due Extent of Base, nor were their Pedicles furnished with the Heads which made so pretty a Figure on the others. All that we could now distinguish was, that the Edges of these Crusts were scalloped in rounded Forms, and their Surfaces loosely granulated between the Stalks or Pedicles, that just began to shoot from the several Parts of them.

Persons not acquainted with the Use of Microscopes will learn from the Management of the different Objects occasionally mentioned in these Essays the Way of employing the several kinds to the most Advantage. 'Tis always best in the Examination of an Object that promises much, to begin with a small Power of magnifying, and from thence to rise by many Gradations to the greatest. 'Tis best also to see the Object first *in statu* in its natural Situation, if that may be, and afterwards by Degrees to examine it in other Forms and Positions; 'tis by this Means we avoid the Errors which scandalize the Works of those who would otherwise have been the Ornaments of this Science; but who examining Parts before they had viewed the whole, and looking on Objects in the Forms of  
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their own Distortion, before they had made themselves acquainted with them in their more simple State, have fallen into Mistakes which we blush to see, and missed of Truths which half their Accuracy under a better Conduct must have discovered.

After seeing all that offered as the Plants floated on the Fluid in the Place where they had grown, we introduced into the Liquor one of those concave Glasses which are formed for holding aquatic Objects with the Fluid about them, under the Focus of the double Microscope; drawing this under the Spots where two or three of these Plants happened to stand very near one another, we had the good Fortune to take them all up entire and undisturbed, together with the Liquor which the Hollow of the Glass brought up about them. We now applied these on the Plate of the Microscope in the Glass, and applying a small Magnifier, could distinguish that what had at first appeared Granulations on the Surface of the Crest, were in reality a kind of hollow, leafy Protuberances, tho' of the Colour and Texture of the Crust, that is, truly fungous in all but Figure.

The Cup Mosses, several of the Lichens, and some other of the less perfect Plants, as Authors idly call them, which have their Organs of Fructification supported on Pedicles, have a foliated, a crustaneous Matter for their Base. The common Lichenoides of so many Kinds, which cover the Surfaces of Walls and old Boards, have this, and in many of them it is perfectly like that of this Fun-

gus, both in its Nature and Origin; rounded in its general Form, scalloped at the Edges, and granulated, or when more distinctly seen, foliated on the Surface. There is indeed a great Affinity between many of these and of these Fungi; and most of the ordinary Kinds shew themselves, first in the Form of a yellow or grey Spot on the Surface of the Stone or Wood to which they grow, just as the Fungus on the Surface of the Fluid, which in both Cases extends in Diameter, and afterwards produces the Stalks or Stems which support the Fructifications.

As the floating about of these little Germinations of Plants gave us an Opportunity of seeing them in different Lights successively, we once or twice caught a View, in which it was easy to distinguish, that there were Roots for the Support of the Crust sent down into the Fluid. These minute Fungi in this differ from the Sea Plants, which all rise from a flat Crust or Base, spread on a Stone or other solid Substance, but without any Appearance of Roots to supply them with Nourishment. That in those Plants is received at the Pores, which are open in every Part of their Surface; but here the Crust is nourished by absolute Roots, in the way of common Vegetables, or, to bring it to a strict Similitude, in the Manner of the Duckweed, the little Nymphæ, the Water-foldier, and those other Plants which float at large on the Surface; and tho' they are nourished by Roots, yet do not send those Roots down to the Mud, but draw their Supplies immediately from the Water. To have an Opportunity

portunity of seeing this casually and imperfectly could not but make us eager to distinguish the whole more accurately. It was with some Difficulty that we got an Opportunity of doing it to our Satisfaction; but at length by Means of a Piece of Horfehair fixed by a Cement to the Side of the concave Glafs, and its other End applied to one of the Plants, we found a Way of fixing it in a slant Position: In this Situation we perfectly could distinguish its whole under Structure. The Surface on this Part was much smoother than on the upper, and resembled in some Degree that of a thick Parchment; from several Parts of this, at small Distances, arose the Roots; they were white, fine and pellucid Fibres, very short and delicate, but at their Extremities defended by a kind of Case, into which they were thrust in the Manner of a Sword into the Scabbard. They always rose three together from the same Spot, and did not descend perpendicularly down in the Water, but spread themselves into a Breadth from the very Centre to the Extremities.

We had Occasion during this Observation to admire, as he who searches into the Œconomy of the Universe must do eternally, the Provision of Nature for the Support of all her Productions: We had from Time to Time seen Multitudes of the animal Inhabitants of the Fluid playing, as we then understood it, about the Plant we had under Examination, and often disturbing our Views. We had discovered that it was to the bustling of these Creatures about them, that they owed the Motion  
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that carried them slowly about to the several Parts of the Fluid: But we had no sooner satisfied ourselves of the Nature of the Plants, so far as their present imperfect Period would let us, than we discovered, on examining these living Inhabitants of the Flood, that what we had taken for Pastime and Play, was no less essential an Employment than that of feeding. We saw them now tearing off Pieces from the Sides of all the Plants, and devouring them with all the Appetite with which we had seen them eat the Pieces of the Seed from which they seemed to have deduced their Origin. It is a Thing not yet to be determined how these Animals or these Plants come into the Fluid which supply them Nourishment; we see one equally numerous in the confined as in the exposed Quantity, the other only in the confined, so that their owing their Origin either to Eggs or Seeds deposited by parent Animals, or floating in the Air, is equally obviated; but come how they will, Nature provides, we see, that they shall be of such Kinds as may be of Use to one another, the Plants producing themselves in a very sudden Manner, and supplying the Animals with Food.

Nature reproduced the Parts of these Crufts at least as fast as the numerous but minute Destroyers could devour them; and the general vegetable Power still continuing, they encreased in Diameter from Hour to Hour, till they had arrived at the destined Size, which was that of the Head of a middling Pin. All this Time nothing appeared toward the Fructifications but the Pedicles on which

they were to stand: These we now began to examine with a scrupulous Attention, and by degrees we found them growing taller: When they had arrived at their destined Height, and not before, we could perceive the first Appearance of the round Heads which had at first called up our Attention in the riper Plants. It was easy to perceive that these were not solid Bodies, nor perfectly smooth on their Surface; they appeared spongy and rough, and it was with a strange Surprise that we saw them, from the Time of their first Appearance in an extremely short Period, grow or extend themselves to more than three times their first Diameter. We could distinguish now that they were truly composed of a Number of slender Bodies shooting like Rays from a Centre, and these at a considerable Distance from one another, but as they were all of an equal Length, making the whole Figure round.

The double Microscope was not so proper for this Investigation as a very powerful single Lens. We fitted up the common Apparatus for examining opaque Objects with a very great Magnifier, and adjusted to its Focus one of the yet unripe Heads of this Plant. The Pedicle on which this stood was a fine glossy mucous Cylinder, hollow and perfectly transparent, its Colour a bluish White, and its Surface perfectly even. The Head on its Top appeared no other than a large Globule, of that fine white transparent mucous Matter which covered, in a smaller Quantity, the Sides of the Pedicle, only that we could distinguish some extremely

tremely minute round Protuberances on some Parts of it, in Form of little Dots. While the Object was before our Eye, we could see these Dots or little Tubercles, raise themselves above the Surface of the Globule to greater and greater Heights, succeeded by other globular Bodies, to which they grew in Form of a String of Beads. As these advanced in Height, the whole Surface of the Globule appeared beset with Points; and as they by degrees encreased in Length, the original Globule decreased also in Bulk, till at length there remained no Trace that there ever had been such a Thing; but the whole Appearance of the perfect Head, was that of a great Number of these slender Fibres, all arising from the Summit of the Stalk, and standing in their several Directions so as to form the Globular Appearance that had struck the naked Eye, just as we see the downy Matter on the Top of the Stalk of the common Dandelion when it is in Seed, which assumes a perfectly globular Form, tho' composed of distant Rays of the Plumage of the Seeds. It is not easy to call up an Image, that on a general View more describes the whole Plant as seen by the Microscope, than the Dandelion in this State, the Leaves of which generally extend themselves every Way into a round Figure, but scalloped at the Edges, resembling the Crust at the Base, as the Stalk and downy Head do the Pedicle and Globule at its Summit, only that the Globule on the Head of the Fungus is less compact, and its Rays vastly more distant at their Points.

On a strict Examination we found these formed each of about forty round Globules, all of the same Size, all of the same pale blueish white Colour, and covered with the mucilaginous Matter which had formed the Body of the Globule, and no way connected but by its Viscosity. The Rays were about twenty-six in Number, and they were somewhat near at their Bases, tho' there far from touching each other, but they were very distant at their Points.

On the Summit of the Stalk between these and round about their Bases, there stood a Number of short and extremely minute Peduncles, each crowned also with its Head. These Peduncles did not rise more than to the Height of the two lower Articulations of the larger Rays, and their Heads were of an oblong angulated Figure, and stood erect. The Peduncles were of the same blueish White with the general Stalk, and covered with the same transparent mucous Matter, but the Heads were of a pale Yellow and dry. While we continued our Observation one of these Heads burst open with Violence. The whole Circumference of the Head was now obscured with a Cloud of rising Dust of the same yellowish Colour, so that nothing could be seen distinctly. While we were admiring this, a second Burst of the same Kind happened, followed by a fresh Quantity of the Powder; after this another, and so on, till for the Time of two Minutes or longer, it was impossible to distinguish any Thing of the Head, but that it was involved in a Cloud of Dust, so fine that it rather had the Appearance  
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of Smoak than of any Matter formed of solid Particles.

When this Confusion was over we could distinguish that all the oblong angulated Heads fixed to the shorter Peduncles had successively burst open in the Manner of the first, and each on its bursting had discharged its Quantity of his fine Powder. The Powder itself was now in Part fallen down, and in Part lodged on the Globules, which formed the Rays of the Head. These, instead of the smooth Surface they before shewed, were now covered all over with it, that viscous Matter with which they were wetted occasioning it to stick very firmly to every Part of their Surface. These Globules now looked yellow in their Turn; as to the little angulated Bodies on the short Peduncles, they had quite altered their Form, they had burst all the way down to the Base, along the Ridges of their several Angles, and were now formed into each a regular Star of eight Points.

This minute Fungus appears evidently from this Account, to be of the Number of those Plants which produce the male and female Parts of their Fructification, or, as is the usual Way of expressing it, their male and female Flowers, distinct on separate Parts of the same Individual. The Heads which stood on the flat Peduncles were evidently the Antheræ, or Apices, and those Peduncles the Stamina; these constituted the whole of the male Flowers, for there is no visible Cup nor Corolla, or Verge of Petals. On the bursting of these, their Farina Fœcundans was discharged in Form of that  
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fine Dust which resembled a Cloud of Smoak, and had attached itself to the Globules forming the several longer Rays, to perform its Office of Impregnation. Thus far the whole is similar to that of the Nature and Use of the Farina in the larger Plants, but the bursting of the Antheræ into this regular Form of a Star with eight Points, was a Singularity more elegant than is to be met with in any thing of the larger kind. For in the very finest and most beautiful Flowers the Antheræ burst indeterminately, and discharge their Contents in Form of the same cloudy Dust, but assume no particular Figure afterwards. As to these, when they have done their Office, they become by much the handsomest and most conspicuous Part of the Plant; and to any one who had not seen their first Appearance, and the Discharge of their Farina, they might very naturally appear each a regular Flower, composed of eight yellowish Petals.

The male Parts of the Fructification of this minute Vegetable had been now sufficiently examined; it remained to enquire into the Nature of the female ones. These still retained their original globular Form, but were rendered rough on the Surface by Means of this Dust from the Antheræ, which had covered them all over. We adapted the largest of all the Magnifiers, a much more powerful one than that usually sold with this Apparatus; it was the first indeed of *Wilson's*, or in other Words, the greatest single magnifying Power that Art has been able to contrive. The Area taken in by this Glass is so small, and its focal

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Distance so difficultly hit, that it is not easy to use it ; but to an accurate and accustomed Hand there is less Trouble, not to say Impracticability in it, than to one less used in these Things ; and tho' the View from it be dark and gloomy, its Power and Distinctness make Amends for all the Difficulties and Disadvantages. It magnifies to a very surprising Degree, and shews with a Precision that we never meet with under the double Microscope, where the Image passes thro' three Glasses before it arrives at the Eye, and consequently never is so determinate or pure, since it partakes of the Misrepresentations owing to the Imperfections of all those Glasses.

Thus much I have thought it necessary to say in Favour of the Use of single Magnifiers of great Power, in the more nice Investigations, because I know their being difficult and disagreeable in the using has thrown them into an unmerited Disregard, a Neglect that will clip the Wings of all succeeding Discoveries. The Microscope, as we hear of it, in the Hands of *Lewenhoek*, and in those of all the other Authors, who have so amazingly seen the Minima of Nature, and who have inspired the World with a Love for its Investigations, was a single Glass of this Kind : Almost all the great Discoveries which have rendered the Instrument famous, were made by single Glasses. These are the only ones to trace with Accuracy the Ways of Nature in these her minutest Productions ; nor are those who are acquainted only with the Use of that Plaything the double Microscope, to wonder that they cannot

cannot follow the Discoveries of Men who have used these single Glasses in the making them; or accuse People of Imposition or Fancy, who have used in their Investigations an Apparatus which is so superior in real Value to that by which they vainly attempt to follow their Steps. The double Microscope is the Instrument for those who would be diverted by the Powers of magnifying, but this is that which ought to be understood and employ'd by all who would make real Discoveries; that may be necessary as a first Step to this, but 'tis the single Glass of the first Power that is to determine all. The Variety of Lights thrown on the Objects from the Reflection of the other Apparatus, gives Things so different an Appearance, that the same Object scarce appears the same, and often, as almost any Object may be drowned to a deep Magnifier, in that Apparatus by a full Light, there is no Degree of it that can properly shew what is searched after. In the single one, the View tho' dark is certain, 'tis always the same; and tho' an Eye not accustomed to it scarce knows what to make of an Object, the practised Observer never fails to see every Thing with a sufficient Plainness, and with a Precision and Accuracy that charms him. I hope the Observations laid down in these several Essays will be repeated by many; they have been repeated so often by myself, that I am confident every Part of them is accurate and just; and I would fain recommend an Apparatus that is at present very little used, but as it is that with which I discovered many of them, 'tis that also which ought to

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to be used in following me with any Prospect of Success.

The Truth of the preceding Observation, in regard to the different Use of the single and double Microscope, cannot appear more evidently in any Instance than in that of the present Enquiry. The double Microscope, used with all its Advantages and in all its Powers, could shew no more of these female Organizations of this little Fungus than that the several Rays were Series of Globules, connected by no Pedicle or Membrane but only adhering to one another by Means of a viscous Matter with which they were covered. The most accurate Observation by this Instrument could shew nothing on their Surface while naked, but an uniform Covering of this Jelly-like Matter, nor when covered with the Dust of the Farina was any thing visible except an inconceivable Quantity of oval Bodies, that, is of the Grains of the Farina, for that is their Figure, thrown irregularly over every Part of it.

On bringing a Globule from one of the Rays of another Head before the single Magnifier, in this simple Apparatus, a new Scene of Admiration disclosed itself. This was taken from one of the Plants in which the Antheræ were not yet burst, and it was consequently in its primitive State, not defiled by the Powder from those Bodies. The Surface which had appeared in all the former Observations smooth and uniform, now discovered a great Number of irregular Protuberances; these, examined strictly, appeared to be each of a triangular

gonal Figure. They were elevated but a very little above the Surface, and indeed were covered in such a Manner by the mucous Matter that overspread the whole, that they appeared to any View, except so accurate a one as this, on the same Level with the rest of it.

In the Centre of each of these angulated Prominences, stood a Body of the Figure of a Segment of a Sphere, which I could observe was pierced with innumerable Holes on its Surface. This was all that disclosed itself in the present State of the Object; but after the Certainty of these Globules being the female Part of the Fructification of the Plant, it was not difficult to discover that these were Apertures leading into the Cells in the Body of it, where were lodged the Seeds; and that these little trigonal Eminences, with the Bodies contained in their Cavity, answered to the Stigmata in the more perfect Plants.

When we had sufficiently examined one of these in the State before Impregnation, we selected a very fair one from among those which were covered with the Farina from the burst *Anthenæ* of another Head: On placing this within the Reach of this magnifying Power, we found the Farina, tho' almost inconceivably minute, all composed of Granules of regularly oval Figure; their Colour was Brown, approaching to Yellow, and their Surface wrinkled, or as it were reticulated. Tho' these Granules lay scattered over every Part of the Surface of the Globule, yet we could see them much more thickly covering some Places than others; they

they were indeed in many Parts raised into a kind of little Hillocks; and when we examined these more minutely, we found that this was always over one of the triangular Protuberances, or, in other Words, that one of the Stigmata of the Fruit was always hid under this Cluster of Farina.

To what Power it was owing that the Globules of this fine Matter assembled themselves thus in Clusters, just where was their proper Place for their executing their Office, seems not easy to determine; but the Fact was evident, and the Intent of it as obvious. The Purpose of Nature was, that this impregnating Matter, or perhaps a yet subtler Substance excluded from these bursting Globules, should make its Way into the Cavities where the Seeds lay, and these Globules were assembled in Quantities immediately over the Orifices which led into it.

The Impregnation of the first Rudiments of the Embrio in the Females, both of the animal and vegetable Creation, seems of the Number of those Secrets of Nature which are wholly inscrutable to us, and performed by Substances too fine, as well as in a way too intricate for our Investigation. It was very long before the World had any Acquaintance with the very Parts of Flowers which served the Office, as appropriated to it. The Pistil, which is the Organ of female Impregnation, and the Stamina and Antheræ, which are the male Organs, and both which appear in the most conspicuous manner in the generality of Flowers, were supposed to be mere Redundancies of Nature and  
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Excrescences of no Use but to receive the too abundant Nourishment sent up to the Flower. It was but within the Compass of a few Years that we have found that these are the different Organs of Impregnation, and that the whole Flower, with all its gaudy Apparatus of Foliage and Colouring, was meant but as a Support and Defence for them.

It was no sooner discovered that these several Parts answered the Purposes of the Organs of the Sexes in Animals, which it is most certain that they do, than, as Men of warm Imagination generally make but one Step from the first dawning of a Discovery to its Conclusion in absolute Perfection, it was asserted that the Foramina in the Stigmata of the Pistil were made for receiving the Globules of the Farina, and that those Globules were the absolute impregnating Matter which reached the embryo Seeds. The Discovery that the Antheræ were hollow Bodies, and that they at a proper Period burst and let out this Farina, was supposed a Thing that proved this. But alas! as subtle a Powder as the Farina, even of the largest Plants, seems to the naked Eye, yet when brought to the Test before the Microscope, and its Globules compared with the Diameters of the Holes thro' which it was to pass into the Cavity of the Pistil, it appears that they are by no means proportioned to one another. The Apertures in some of these female Organs are not even visible, except by the Microscope, and then appear by no means equal to the receiving such Particles.

It has been found that even these Particles of Farina, minute as they seem, are no other than Capsules, containing a yet more, infinitely more subtile Matter, which issues thro' the Orifices in Form of Smoak when they burst on being laid in Water. This Matter, thus issuing from those of some Plants, and probably the Case is the same in all, is so very fine, that no Glasses have been able to discover the separate Particles which compose it. This may indeed be fine enough to get into the most minute Apertures, or even to make its Way into such as are as imperceptible as its own constituent Particles, and so to impregnate the Seeds in the Capsule. This seems a rational System of Impregnation so far as it goes; and according to this, the close and seeming solid Texture of the Stigmata of some Plants is no Objection to their Use, or to the Effect of these Globules of Farina communicated by their Means.

In the present Case the Apertures, tho' visible to these great Magnifiers, were not equal to a fortieth Part of the Diameter of the Globules of the Farina, which were thus clustered over them. It is utterly absurd to suppose that the Power of Suction which has been pretended to do the Office, or that any other mechanical Agent can be of Force to make such disproportioned Bodies enter such Cavities; but supposing these to be of the Nature of the Globules of Farina in those larger Plants, and to be themselves only Receptacles for a subtler Matter, the Process is so far plain, that

while they lie clustered over the Stigmata of the female Fructifications, and all about their Apertures, the subtle Matter with which they are filled, must, on their bursting and discharging it, fall into the very Apertures destined to convey it to the yet unimpregnated Seeds, and, without any miraculous Power, be carried down to the very Place where it is to perform its Office.

Such in general do I imagine to be the Course of Nature in the Fructification of this little Plant: The Fruit or Capsule containing the Seeds is placed at a small Distance from the Antheræ or Capsules, containing the impregnatory Farina. There are Apertures to convey the Contents of the Globules of the Farina, down to the Embryo Seeds, and the mucous or glutinous Matter, which covers every Part of the female Globule, but more particularly these Stigmata, serves to receive and detain the Globules of the Farina discharged by the Burstings of the Antheræ, till themselves burst in their turns, and discharge their Contents just over the Orifices destined to convey them to the Seeds.

Here is an Apparatus as complete and as elegant as any in the larger vegetable Bodies; and we need only Organs to see it in order to the paying it as much Respect, and bestowing on it as much of our Admiration. The Microscope indeed, in its several Destinations, does nothing less in regard to our Conceptions than the creating new Worlds, new Series of Beings for our Inspection.

When we had thus far pursued the Progress of Nature, in the Structure of the Parts of the Plant,  
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and their evident Uses so far as they regarded the Impregnation of the Embryo Plant in the Seed, we devoted an Hour or two more to the Event of all this elegant and regular Apparatus. To this Purpose we had recourse to the Microscope fitted to a moveable Joint, by which we had at first seen the Plants in Statu, and by Means of which, with a more powerful Magnifier, we now determined to trace the Fruits from their Impregnation to the Production of the future Plant. This, in regard to the common Rank of Vegetables, whose Periods of Growth are more slow, and whose first Disclosure is made under Ground, would have been at once difficult and tedious; but we had here an Opportunity of tracing it in a Vegetable, whose whole Time of Existence, from the Embryo in the Seed to the decaying Plant that had performed its Duty, was gone thro' in the Compass of a few Hours, and whose first Shooting was performed in the open Air and on the Surface of a Fluid.

The last Examination we made of a single Globule or Capsule, taken from one of the ripening Rays, was that its Stigmata were twenty-four in Number, and placed at equal Distances; and that the Capsule, when broken, seemed to have just so many Lodgements or separate Cells for Seeds, tho' that was scarce to be determined with any Degree of Certainty. From this last separate Observation, we turned to the Examination of a very flourishing Plant in Statu on the Surface of the Fluid. The Antheræ on this had been some Time

burst, and the Globules of which the several Rays were composed were consequently covered with the Powder discharged from those Bodies. It was not long before we saw the extreme Globule of one of the Rays, without any external Violence, or other visible Occasion, fall off and float upon the Surface of the Water. The extreme Globule from another soon dropt like that of the first, and the rest following the Example, the whole Head was reduced at once regularly to a smaller Diameter. It was some Moments before any Thing more happened, but then another Series of Globules drop'd off, one from each; and in fine, they all fell into the Water, in the same regular Manner at distant Intervals, and the Head gradually lessened more and more in Diameter, till at length nothing remained but the opened Antheræ without their Farina on the Top of the Pedicle.

While the Plant might, in this State, have been taken for a different Species, the Globules, which had by degrees fallen from the Rays of the Head, were floating in Numbers on the Surface; the greater Part of them applied themselves to the Sides of the Crust or Cake of Plants of the same Kind, which covered the greater Part of the Surface of the Fluid; some of the others burst under our Eye and disclosed their Seeds. The Muddiness of the Liquor below, prevented our seeing the Progress of this Operation of Nature so minutely as we could have wished, and to obviate the Accident, we had Recourse again to the double  
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Microscope and the Concave-Glafs, in which we had before observed the growing Plant.

We filled this with the clearest Water, and shaking over it a Quantity of the ripe Heads of the Plant from the Gally-pot, we found the Surface covered with Globules: We kept an Eye constantly on these till they began to burst; we then found the Number would occasion Confusion, and separating the greater Part of them and adding fresh Water, we at length procured a few in a good State, not discommoded by others, and in a perfect and proper Condition for Observation. It was now that we made the Discovery which compleated to us the whole Progress of the Vegetation. We had before traced it from its first Appearance in Form of a simple Crust to the ripening of its Seeds, it remained only to fill up the Gap between the State of the ripe Seed and the Appearance of this Crust, and this we now had Opportunity of doing in the most full and perfect Manner.

A Globule very soon burst under our Eye, and we saw a few Seeds scatter themselves from it: After some Moments more and more fell out, till in a little Time the whole Surface of the Fluid was covered with them. They were perfectly round, and of a white Colour; and such was their Number, that it appeared unaccountable what could prevent their multiplying the Plant in a most surprising manner. It appeared so to us indeed, who were viewing the Object in a Condition into which we had placed it out of the Road of Nature; but

as that careful Manager provides for all her Productions in the easiest and simplest, as well as the most perfect manner, it is undoubted but that this vast Abundance of Seeds has its Use in her general Œconomy; and as she has peopled the Fluid beforehand with Millions of voracious Animals, 'tis most probable that these are their destined Food. In this unnatural State in which we had placed them, the Surface of a large Extent of Liquor proportionably to the Magnitude of the Fruit, was so covered with the Seeds from this one Globule, that we were forced to clear it away again, to have room for Observation. We took away more of the Water and added fresh in new Quantities in its Place, till there were of all the original Number only about a dozen Seeds left on the Surface.

We spent an Hour in watching these in vain, nothing happened, but they swam about the Liquor at random, or applied themselves to the Sides of the Glass. Some Accident called us away for an Hour more, and at our Return to the Observation at the End of that Time, we saw a very remarkable Change in the Face of Things: Two or three of them had begun to shoot, and the rest, which had before suffered no Alteration, were now swelled to twice their natural Size. It was not long before we saw the Process of the first Germination repeated in several of them, it was extremely simple and perfectly similar in all.

The Seed burst open on one Side just on a Level with the Surface of the Water, and there appeared

an oblong Protuberance ; this extended itself without altering its Form, to about four times the Diameter of the Seed, and then it began by Degrees to expand and unfold itself. It now soon took up so much Space as to render the Body of the Seed inconsiderable ; and as its Expansion was still in a circular Form, it at length surrounded the Seed, which was lost to View, tho' it must in the End have occupied exactly the Centre of the Body.

We saw several other of the Seeds shoot in the same Manner, and in the same Manner expand into a round Figure : Thus was formed that flat Crust which we had first observed in the Rudiments of the Plant on the Surface of the original Liquor ; and thus had we traced the Vegetation thro' its compleat Course. It is singular that the Rudiments of the Pedicles which support the Heads in the perfect State of the Plant, seem to exist in the *Plantula Seminalis*, even while in the Body of the Seed : We traced them as far back as possible, but we never failed to find them very evident, and even of some Height above the Surface, in the very first unfolding of the Germination.

Thus appears and thus lives a Plant produced, so far as we yet know, only on the Surface of one peculiar Fluid, and that by the artificial Infusion of the Seed of a Plant : Thus does it, like the Ephemeron among the Animals, go thro' the whole Course of its Life in one Day, producing a Brood of young ones like itself and those of others in Succession, for the Food of an Insect, which,

were it many hundred times larger than it is, would not be visible to the naked Eye. And thus does the Microscope shew in that Vegetable, an Organization equal to that of the most perfect, as we express it, of the Plants; and in that Animal, a Structure of Limbs and Apparatus for Motion and Feeding, scarce to be equalled in the whole Course of her larger Productions.



E S S A Y VIII.

*On an Insect found on the blighted Branches of Fruit Trees.*

THE Health of a Person very dear to me rendered it necessary for me to reside many Years, during the earlier Part of the Spring Season, out of the Smoak of *London*: I had on these Occasions Lodgings in a Part of *Chelsea*, where there was a little Garden behind the House, well planted with Trees, but seldom producing much Fruit. The general Disorder was what is termed the *Blight*, and there were few Seasons in which this Spot escaped the Mischief. When others suffered, these Trees were wholly barren; and in more favourable Seasons they produced but little.

An Opportunity of daily Observation led me to investigate the Nature of this Disorder in Trees, and the Observations I made on these upon the Spot where I resided, led me to others on such as were situated under happier Exposures. I have been led by the Course of these Observations to think extremely contrarily to the Generality of the World on this Subject; but in my particular Opinion, 'tis not only Observation, but Reason that is in my Favour. The received Opinion in regard to this Mischief is, that it is owing to certain Insects supposed to be brought to the Trees by particular Winds; but this is not only an unnatural Determination,

nation, and unsupported by Observation or Experiment, but it leads us from an Enquiry that might have explained the whole on the System of a better Philosophy, and under Countenance of an Analogy with the rest of the Processes of Nature.

We are well informed, that both animal and vegetable Substances, when approaching to a State of Decay, become at once a proper Nidus, and a Supply of Food to Insects of many kinds, who could find neither Habitation nor Support in them while in a healthful State; and we also see that no one of these, however free from these Insects while in Health, never either by Accident, or by our own Contrivance, falls into the State proper to their Support, but Nature peoples it instantly with Myriads of them; tho' it is impossible for us to guess from whence they come. Expose but a Morfel of any animal Substance, or bruise, or otherwise cause to putrefy any Part of any Vegetable, steep but a Seed in Water, or lay a Leaf exposed to the Dews, and the altered State of it affords Food for some Species or other of the smaller Animals; nor is it sooner in that State than there are the Animals in Multitudes upon it, that can feed only on it. While the Flesh remained upon the Body of the Animal, while the Leaf, the Stalk, or the Seed continued to grow upon the Plant, and either received Nourishment from the Root or from the Circulation of the Juices, no Creature of this parasitic kind had Place on them. But to continue the Analogy, for there is no fairer way of reasoning, when the immediate Causes and

Means

Means are hid from us, as if the Flesh by any Accident putrefy upon the Animal, there will be produced Insects in it as certainly as if separated from the Creature; so we have no Reason to doubt but that an altered State of the Fluids, either putrefying, or approaching to Putrefaction, may as well afford a Nidus and a proper Food for Insects, while the Branch remains on the Tree or if separated from it.

On these Principles it is that I would found the new System of what is called Blighting, in our Fruit Trees. The Cause I take to have been overlooked, and the Effect confounded with, or mistaken for it. The Multitudes of Insects which are found on the Branches and Leaves of blighted Trees, are generally understood to be the Cause of the temporary Decay of the Branch and of the perishing of the Fruit; on the contrary I am convinced by repeated Experiments, that the Appearance of these Insects is subsequent to the Mischief.

The Juices of Animals and Vegetables, while in their healthful State, and circulating in their proper Channels, I have observed are not Food or Nourishment for Multitudes of Insects, to whom they became delicious when altered from that State, nor while in it are they ever sought after by them. Stagnation, both in the animal and vegetable Fluids, is the first Approach toward Putrefaction, and whatever brings on the one endangers the other. I have observed also, that it is not an absolute Putrefaction that is necessary to the concocting these  
Juices

Juices into a proper Food for Insects; an Approach toward Putrefaction will do it; that is, a Stagnation will do it. There requires then no more than some accidental Cause, whether natural or artificial, to occasion a Stagnation in the Juices of a Tree, or of one particular Branch of a Tree, and we shall find them in a Condition to nourish Multitudes of Animals that could not before have been supported by them: And we have before seen in numerous Instances, that no sooner is a Body reduced to a State of thus feeding those Creatures, than they appear in Myriads upon it, tho' we know not how, why, or whence.

That there are many Accidents, as well natural as artificial, which may prevent the regular and free flowing of the Sap or Juices in Vegetables, is very evident; nor is it less so, that whatever causes but a partial or temporary Stagnation of this kind, puts the Juices into a Condition in which they will afford Nourishment for Insects of a peculiar kind. We find the most weakly Trees, and those which are planted in the most unfavourable Exposures, the most frequently blighted; nor is it owing to Insects brought by an East Wind, that Trees exposed to that Quarter are the most frequently affected by the Mischief, or the first that feel it when the Misfortune is general; but because this Situation is the least favourable, and the Trees under equal Circumstances in other respects, are least hardy that are in it.

A harder Winter than ordinary will at any Time kill many of our Fruit Trees, and those which fall  
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so it are always the most weakly. Where a whole Tree is not destroy'd, if there be one or more of its Branches weaker than the rest, that or they perish, while the others escape. What a severe Winter will do to many Trees, or to whole Trees, a few untimely Frosts may do to a few of them, or to the weaker Parts of those. The Manner in which a Frost affects a Tree is by occasioning its Juices to stagnate; and it is not therefore a Wonder that a less intense or severe one will do this Mischief in Spring, at a Time when the Juices are afloat, than would have executed the Destruction in Winter, when the Circulation was more languid and the Juices neither so abundant nor so fluid in their own Nature.

These are the Observations and Arguments on which we may hope to arrive at a true Knowledge of this Phænomenon, which has so long perplexed and misled the Curious. A Frost happening at a Time when the Juices are afloat, will occasion a Stagnation of them, either entire or partial, either permanent or temporary. If the Frost be trifling, the Vigour of the Tree overcomes it under the Influence of the next Sun; if more intense, it hurts more or less in Proportion to the Degree of that Vigour: If the Tree be weakly, it may perish throughout, or at least be so far prejudiced throughout, as to produce nothing the whole ensuing Season; if it be weakly in Part, the Accident will affect that Part. Wherever it affects, there is a continued Stagnation of the Juices; that is, there is an Approach toward their Putrefaction; and they

they are by that Change brought into a State in which they will afford Nourishment for Animals; that could not otherwise have lived upon them. Nature in her usual, her unaltered Course, brings to the Tree the Animals which are formed for feeding on the altered Juices. The injured or distempered State of the Tree, and these Insects which profit of it are discovered together; and People who think no farther backward declare the Creatures who are fed by the Mischief to be the Occasion of it.

If these Insects, which are always found upon blighted Trees, were the real Occasion of that Blight, it would be impossible for Men to produce it by artificial Means: But this is not the Case; it is possible to bring on a Blight at Pleasure, by starving or otherwise injuring a Tree or Part of a Tree, when the Season favours the Operation; and these Insects will be found as regularly, and in as great Numbers on the Trees injured by Art, as on those hurt by Accident. I have found it upon repeated Experiments, that as of two Trees, the one strong, the other weak from Nature, the weak one shall be blighted at a Season when the strong one shall escape: So of two Trees, the one of which is rendered weak by Design, the other left in its natural better Situation, the weak one shall be blighted while the other escapes; and Myriads of Insects shall be found on the one, while there is not the Appearance of a single one upon the other. If the Earth be in great Part taken away from about the Root of one Tree of a whole Row, the rest are  
left

left in their natural State ; that one, if the Season be but a little unfavourable, shall be blighted while all the rest escape ; and I have found it possible, only by the Use of Ligatures and Bandages, to do the same Thing by a single Branch of a Tree, otherwise healthful. I in this Manner procured Millions of these Insects about one Branch of an Apricot-Tree at *Chelsea*, while all the rest was clear of them ; and this under the Observation of several Men of Genius, whom I desired to be Witnesses to every Part of the Operation.

It appears then from the whole, that the Tendency of Frost is to coagulate and impede the Circulation of the Sap in Fruit Trees ; and that it has that Effect in Proportion to the Vigour of the Tree ; that a Tree weakened by Art, or a part of a Tree injured by Bandages, will be affected by this Agent at Times, when the vigorous Tree, or uninjured Parts of the same Tree, suffer nothing by it. It appears also, that the Injury which the Tree receives is the Stoppage of the Circulation of its Sap and the congealing or coagulating it : That this Coagulation and Stoppage of its Motion puts it into a State tending to Putrefaction, and that in that State it becomes the Food for Insects, which never fail to be present when there is such Food for them. Thus it appears that these Insects do not occasion the Blight tho' they profit of it, and that they are no more to be accused of causing the Putrefaction of Juices than of those of any other animal or vegetable Substance, in the Putrefaction of which they or other such are found.

Having

Having thus far pursued the untrodden Path of this Investigation, and endeavoured from Reasoning supported by Experiments, to prove what the Injury, called a Blight, on Fruit Trees, is not, and also what it truly is, I am led to the immediate Subject of this Essay, the Insect found on the Trees thus blighted and injuriously charged with occasioning the Mischief. The several Trees blighted in different Years, and even the different Trees of the same Year, and the same in different Years, afford distinct Species of Insects. It should appear, according to this Account, that different Insects were enabled by Nature to occasion a Blight, or that almost any Insect in proper Number was so; but the better and more rational Solution of the Appearance is, that when the Juices of Trees are vitiated by this Accident, or coagulated by a Frost, which has more Power to hurt than the Vegetation has to overcome the Obstacle, they become the proper Food of different Insects. That the several Species of Trees and Plants, as in their natural State they feed each its peculiar Caterpillar, or some those of two or three kinds, so when they are thus altered by Accident, they afford each a Nourishment to some peculiar lesser Insect, and some to several Species.

If we bruise the Leaves of several Plants and set them to putrefy in their own Juices, without any Addition, we shall see the fermenting Matter teem with Life, and that of various Kinds, on only being exposed to the open Air in Summer. The Solanum, in this Case, affords a hairy Worm;  
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the Chickweed, a smooth one; the Elder, a large Species; and the Groundfel, a small one. These we may indeed have from the Eggs of Flies of various Kinds, which are deposited in the Matter, even in our Sight, and if we keep the Insects their due Time, may trace their whole Progress into the Fly again. In the same Manner, tho' the Means are less obvious, when the several Trees in an Orchard are found to be blighted, that is, when their Juices are stagnated and brought into an Approach, at least to Putrefaction, we see them all, like the Quantities of the bruised Matter, in the other Case, covered with Life; and we discover on the Apple-Tree one Insect; on the Cherry another; on the Plumb a third, and so on, tho' with no more Regularity or Certainty than in the other Case; in which tho' there appear a general Difference in the Insect according to the Matter, yet the same Parcel shall sometimes produce two Kinds and two different Plants thus bruised, the same.

I had observed several different Species in the Compass of the single Garden, where I made my Experiment; but the Creature, which is the Subject of this *Essay*, and is one of the most singular and most beautiful of them, was produced on a Branch of a Tree, the rest of which was in a flourishing Condition, and the ill Success of this Part owing to the artificial Means of Bandages, assisted by a moderate Frost. The Branch I had fixed upon, was one of the most beautiful and vigorous on the Tree; the young Shoots had been cut off from it pretty close

the Year before; it was full of what the Gardeners call Bearing-wood, and promised a plentiful Loading. On my applying the Bandages and using whatever additional Methods occurred to me of assisting the coagulatory Effect of the Frost, the Leaves shrunk up, and the whole Face of the Branch declared it to be, what is understood by the Term *Blighted*, in the most regular and natural Manner; while all the other Parts of the Tree were in perfect Health. It was not till after two or three Days that the Effect of the Applications appeared: At first the Branch seemed profitted by them, and promised to be more vigorous than any other Part of the Tree; but on the fourth Morning the Leaves drooped, and from this Time they became more and more flaccid, and the Branch put on a more and more sickly Aspect. It was not till on the Morning of the sixth Day, that is, two Days after the first Appearance of the Sickliness of the Branch, that I discovered any Insects on it, a very plain Proof that it is not those Insects which occasion it. On this Morning however, it was not a few here and there that shewed themselves, but the whole Branch was covered with them: They were crawling all over the Bark and clustered about the Buds, the Leaves were covered with them, and in short, such an Army of Destroyers scarce can be conceived. They were not a young Brood produced from Eggs, or from Worms\* hatched from Eggs of their Parents, deposited on that Part of the Plant. It is impossible that the general Order of Nature should point out to such Parents, a Branch  
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which not natural Causes, but my Experiment only, was to render fit for their Supply. They were at their full Growth when they first appeared, so that they could not be just then produced from the Egg; and if from Worms, in the common Way of Change in the winged Insects, it could not be on that Spot, since there had not been Time for the gradual Progress of such an Operation; nor had the Worms, as must have been the Case had there been such Numbers of them, been seen on the Branch before.

Whence they came seems too difficult to ascertain, but this will assist toward the conceiving the Manner of their coming that they were winged Insects, tho' I never saw them make any Use of their Wings afterwards; nor could the strictest Search over all the Trees, in the neighbouring Gardens and Fields, discover any thing like them any where else: It would have been natural enough to suppose them a Colony sent off from some larger Community, but the Means by which they should be led to this single Branch which offered them Food, was not the only Difficulty in the Way to this Opinion, since no such Community of them could be found.

Tho' these Creatures evidently were not the Occasion of the Blight, they had a considerable Share, I found, in the Appearance the injured Branch afterwards put on. From the loose State of the Bark and flaccid Appearance of the Leaves, the former was soon corrugated, and drawn up into hollow Ridges, Lines and wrinkled Protuberances;

and the Leaves which had at first only hung and seemed faint and languid, were now curled up about the Bodies of the Creatures. This it was easy to see was owing to the Wounds inflicted by the Insects in their feeding: And thus far, tho' no farther, is it that the Inhabitants of the blighted Branch or Tree, are instrumental to what we see on it; the particular Form of the Leaves and Surface, depended on the altered Course of the Juices from their Wounds; the Distemperature of those Juices to very different Causes.

It was easy to see by the Motions of these Creatures, what they were employing themselves about, and they were so numerous, that it was as easy to find an Opportunity of seeing all their Operations in one Part or other of the Branch at the same Time. In some Places one might see Troops of them running after one another as if in Wantonness and meer Play; in another, they were so clustered together that they were climbing upon one another's Backs; in a third, they were vibrating their Wings; and in the greater Part they were quite stationary, fixed without any Appearance of Motion, or even of Life, and feeding, tho' it was not easy to see on this general View in what Manner.

I took off several of them singly from the Branch, and when I had selected a large healthful and entire One, placed it before a small Magnifier in the common Apparatus for examining opaque Objects. Before I mention any thing of its Appearance under this Advantage, it will be proper to say, that to the naked Eye it appeared of the Bigness of a  
small



small Flea, of a deep blackish green Colour; and beside the Wings, it was easy to discover six Legs, and a slender Engine descending from the anterior Part or Head in Form of another Leg, but shorter. This is all the unassisted Light discovered in an Insect, perhaps, in Reality, one of the most beautiful in the Creation.

The general Form, exhibited by the View from the Microscope, was that of an oblong Animal, smallest at the Head, and gradually larger to the opposite Extremity: The Body thick, rounded, and appearing inflated; and the Limbs very slender in Proportion to its Bulk.

The Head is rounded, and the Eyes are very small, but extremely beautiful; they are of a deep black, but extremely bright and glossy, and stand at a considerable Distance on the Sides of the Head. The anterior Part of the Head, instead of opening in Form of a Mouth, is terminated by an oblong slender rounded Engine, thicker than the Legs, and answering, both in its general Form and in some degree in its Office, to the Trunk of the Elephant: The Difference between them is, that this is pointed at the End, and is the sole Conveyance for the Food into the Body of the Animal. This Engine is of a very beautiful Structure; it is largest at the Base, and thence gradually smaller to the Point at the End: Its Colour is a bright and splendid Green, and it is in a great Measure transparent: It is formed of no fewer than eight Joints, which run into one another in the Manner of the Joints of

our modern Telescopes, and consequently, by the Power which the Creature has of thrusting them out or drawing them in at Pleasure, it is capable of being lengthened and shortened just as the Occasion requires. Its Point is hard and very sharp. At a small Distance, above the Extremity, there are two oblong Apertures in it, one on each Side; and there seems also a circular Orifice for the letting up the Juices between the Circumference of its Base and the inner Rim of the lowest Joint of the Trunk, out at the Extremity of which this is thrust, and seems rather an Appendage to that Engine than a Part of it. This Extremity of the Trunk is not to be seen, unless when the Creature is forced to protrude it by squeezing the upper End of it between the Joints of the Forceps, which make a Part of this Apparatus; but when thus protruded, it shews very plainly in what Manner the Creature feeds: This Point makes its Way into the Substance of the Bark or Leaf, and carries the first Joint of the Trunk in with it: The Wound which it makes extravasates some of the Juices, and the Power of Suction, which all the Trunks of the Insect Kind seems to have, draws out more, all which is received in at the Apertures on the Sides of this Point, which appears to be every where hollow except immediately at its Extremity, and at the circular Opening between the Circumference of its Base and the Ring formed by the Verge of the Trunk. It is all carried up by the same Power of Suction, along the whole Cavity of  
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the Trunk to the Body of the Animal, and there is received into a Stomach strangely disproportioned in Size to the general Bulk of the Creature, and causing that uncommon Distortion of the Body.

On the very Front of the Head, between the Eyes, but a little higher up, there stand a Pair of Antennæ, or, as they are vulgarly called, Horns. These are of a singular Structure and extream Beauty: They are as slender as the finest Thread, and are in Length more than equal to the whole Body. They appear to the naked Eye as simple Filaments of a blackish Colour, but in this nicer Examination they are found to be of an articulated Structure: Each is composed of about fourteen Joints, and those all of the same regular globular Figure, but alternately of a deep Purple and a glossy black Colour. The Joints are largest at the Bottom, and gradually smaller all the Way to the Top, where they are inconceivably minute: At the Bottom they are affixed to an oblong or elliptick Body, which is not so properly one of the Joints as a kind of Support to the whole: This is infixed into the Head, and forms a kind of Curvature or Knee in its joining to what is properly the lowest Joint of the Antennæ. The Purple and the Black of the alternate Joints are both very glossy and beautiful: The Joints themselves are perfectly round, so that they touch only in so small a Point, that one wonders how they adhere to one another; and in the whole, they have exactly the Appearance of a Necklace, strung with alternate black and purple Beads. The Structure of the Antennæ of this

Insect is not all that is curious in them, they are carried in a different Position from those of most other Creatures which have them, for as those are usually either bent backwards, or at most erect, these are protruded immediately forward.

The Head offers nothing farther remarkable, except that its hinder Part where it descends toward the Juncture with the Thorax or Breast, is of a polished Surface that exceeds almost the brightest Lustre of the wrought Gems. The whole Body is of a deep green Colour, with somewhat of a brassy Tinge in it: The Thorax is short and thick, but it is flatted on the upper Part: It is of a deeper Green than the Head; there is indeed a Tinge of Black among it, and the yellow or brassy Lustre that is seen in some Degree on the Head, is scarce at all distinguishable in this Part. The whole Surface is perfectly smooth and glossy, but there is an elegant Variegation on each Side, at about the Midway between the Edges and the Centre; this is a broad trait Line, of a deep and fine Purple, the same Colour with the alternate Joints of the Antennæ, only more beautiful and glowing.

The Body is of a Figure approaching to Oval, and so swelled, that it appears inflated. Its Colour is an elegant deep Green, with some Tinge of Blackish, but with a fine and bright Shade of a brassy Yellow; and along both Sides there run two Series of Dots of the same beautiful Purple with the Lines on the Breast, and forming two Lines on each Side the Body, correspondent to the single  
Line

Line on each Side. This Admixture of Purple is wholly undistinguishable to the naked Eye, tho' it make so beautiful a Variegation in the Animal when distinctly seen under the Advantage of the Microscope; and it is very singular, that we see not one of the real and genuine Colours of the Insect, neither this Purple, nor the Green, nor the Yellow, nor the Black, but a confused Tinge from the blending of the whole, which appears rather a brownish Black, or a deep Iron Grey with an Admixture of Brown, than any other Colour.

The whole Surface of the Body is of the same elegant Polish with the Back of the Head and the Breast, and towards its hinder Extremity there stand, as it were, a Pair of other Horns, resembling in some Degree the Antennæ of the Head when viewed only by the naked Eye, but when seen with the Assistance of the Microscope, they are found to be very different. They are not of more than half the Length of the Antennæ, and are of a simple Structure, largest at the Base and smallest at the Points, but they are not jointed, and they want also the Variegation of those elegant Bodies in the Colouring, these being simply of a pale Green. They arise from the two Sides of the hinder Part of the Body, a little above its Extremity, and are protruded strait backwards as the Antennæ are strait forwards. The Use of these singular Appendages is not easily ascertained, but they give the Animal a very odd Appearance.

The Legs are six, they are all of a beautiful pale Green throughout, except at the Joints, where they

they are brown; they are very slender and very long, and when in the usual Position in a State of Rest, the Knee, if the middle Joint may be so called, stands higher or reaches above the Level of the Back. They are of a simple Structure, except at the last or lowest Joint, where they have several Incisions or transverse Lines, which give the Appearance of that being composed of several lesser Joints; and at the Extremity of this, on each Leg, there stand three sharp Claws or Toes, of a bony Substance and black Colour, which seem calculated for laying fast hold of any Thing, or plunging into the Surface.

The Wings are four, they are all moderately large, in Proportion to the Size of the Animal. The two outer ones are larger and of a firmer Structure than the inner Pair; but they are all four usually carried almost erect. The general Colour is a pale Brown, with a bright silvery Tinge; the outer Pair are darker, and have least of this; the inner ones are paler, and the under Surface in particular is very silvery. The outer Edge of each of the upper is surrounded with a kind of broad Band or Rib, much thicker in its Substance than the rest of the Wing, and of a deep Chocolate Colour; the other Edge of the same Wing has a very narrow and thin Edge of the same Colour, only paler, and there run within this three Rows of Spots of the same deep Colour; the outer Row of these is largest, and the inner of all quite inconsiderable.

The under Wings have nothing of these Rims of a different Colour, nor any regular Series or  
Lines

Lines of Spots, but when carefully examined, they are found to be all over besprinkled with minute Dots of the same kind.

Such is the wonderful Structure of this disregarded, this inconsiderable Animal, confounded by the Ignorance of those under whose Cognizance it falls, with a Multitude of others as different as can well be imagined, and even in this Aggregate known only as the imaginary Author of a Mischief which it profits of, but which it has no Power to occasion.



1871  
The first of the year, the weather was very cold and the ground was frozen. The snow was very deep and the wind was very strong. The people were very busy and the work was very hard.

The second of the year, the weather was very warm and the ground was very soft. The snow was very little and the wind was very light. The people were very happy and the work was very easy.



1871



E S S A Y IX.

*On the Growth and Fruëtification of an uncommon Sea Plant.*

**D**URING the Time of one of those Visits, which I can never remember without a Tear to the Memory of that truly great Man to whom they were paid, at *Goodwood*, I had made Excursions into several Parts of the adjacent Country, and among the rest to the Sea Coast, in that Part where at low Water the Shore is in a manner covered with those separate Mosses of Stone called the *Bognor Rocks*. I found them affording the Place of Growth and the Means of Shelter and Defence to numberless, and many of them unknown, Animals; but as my Attention was always awake to every Part of natural Knowledge, I was here much struck with the Observation of the Remains of other larger Animals, immersed on the solid Substance of the Stone. I could trace the Lineaments of Shell-Fish of several kinds in these, as perfect as those now living in the Seas, about their Base, tho' perfectly converted into Stone. I was eager to carry the Observation farther by dislodging some of them from out the solid Rock and viewing them entire, but the Evening was coming on, and the want of Tools to have broke a Way into the Stones also prevented it.

A few Days after I returned at a proper Time and better prepared for the Business: The Ebb of the Tide had favoured me with the Means of getting at some of the more remote from the Strand, and I had loaded a Servant with the petrified Remains I had been so industrious after, still receding as the Tide in its Return flowed in, from the more distant to those of the Rocks which were nearer the Shore. I was sitting at length on one of these which had its Foundation on a more heightened Part of the Shore, and picking out some farther Treasures as the Sea beat upon its Base. There was some Wind, and that drove directly toward the Shore, and in Consequence the Surface of the Water brought whatever light Matters it was fraught with that Way: A Number of these stopped at the Foot of the Rock on which I was posted, and as I was occasionally casting my Eye upon them I could discover, beside the Fragments of Sea Plants and a thousand other Pieces and Scraps of different Matter, a Number of round and, as it seemed, entire Bodies. It was not easy to get at any of these from the Place where I then was, but as they were directed to other Parts of the Shore as well as this, a little waiting in a flatter Place gave me the Means of taking up several of them.

On a nearer View it was easy to distinguish that they were Sea Plants of the *Alcyonium* kind; one of the supposed least perfect Genera of the whole Class of Submarines, and were of that Species which *Imperatus* and many other Writers have mentioned, tho' none of them have had any tolerable

rable Acquaintance with it, under the Names of *Aurantium Marinum*, *Malum Marinum*, and *Bursa Marina*; the Sea Orange, the Sea Apple, and the Sea Purse. I was glad of an Opportunity of enquiring into the Nature of a Vegetable hitherto so much unknown farther than as to its external Figure, and ordered several of them to be put up to be taken home with me.

What I had met with, tho' they appeared tolerably intire, there was great Reason to suppose had been damaged in some Degree at least, in their internal Structure, as they had been dashed about by the Waves. As it was not easy to see whence they should have been brought to this Shore, it occurred to me that they might very probably have been first washed off from it, and after floating away with the Ebbing of the Tide, have turned again with its Flood: The Suggestion did not deceive me, I began to search carefully for them in a growing State, and I became at once ashamed of not having discovered them before in my professed Search after the Sea Plants, and convinced how easy it is for People who want the proper Informations, to seek in vain for Things which are very plentiful in the Places where they miss of them. It is a very useful Thing in the Writers of natural History, when they describe an unknown or an uncommon Production, to say in what Place they found it; but we have seen enough almost to discountenance the Practice. Our *Woodward* in regard to Fossils, and *Ray* in Plants, have carefully done this; I dare say both have executed it faithfully

fully and accurately, and yet we meet with People who call them Fools and Liars, because they have looked into the same Places and have not found the Things. Tho' there is not required as much Genius to follow another in a Discovery as to make it, there requires however some: And this Instance of the Ease with which a Thing may be overlooked, even by an accustomed Eye, may serve to vindicate the Characters of those great and worthy Men in regard to such Aspersions, and to caution those who undertake the yet more arduous Task of following Men of Accuracy and Abilities in their Microscopic Investigations, not to be hasty in declaring others have not seen the Things they relate, because they cannot distinguish them. I do not hint this as a Support of my own Cause in these Essays; the Knowledge of the Microscope is at this Time so familiar, and the Apparatus of the several kinds so easy of Use, that I cannot doubt the most unacquainted following me successfully throughout; but 'tis in Countenance of the Names of *Lewenboek* and others of the dead Worthies in these Researches, that I have said so much.

After these Observations, which as I intend these *Essays* as a Means a leading People into the general as well as particular Methods of Observation, and of initiating them successfully in every Road of the Study, I shall not allow to be Digressions from the Purpose, tho' from the Subject, I shall return to the Plant, the first vain Searches after which, and the succeeding efficacious ones, occasioned them.

The Plant itself was rounded except at the Base, and very much resembled a small Orange, from which a Segment had been cut off: Its Colour was of a dusky Green. The Rocks, I have already observed, were full of petrified Shells; these were principally of the Cockle kind, and as their larger End often stood out prominent above the Level of the Stone's Surface, they formed Appearances not unaptly resembling the Plant adhering to the Rock in this Form. To this it is to be added, that a great Part of the Surface of these Rocks, and most of all their Bottoms, were compleatly covered with that green slimy Matter which we see upon the Surface of Stones and Wood on the Borders of Rivers: This Matter was wholly of the same Colour with the natural Surface of the Plant, and consequently the Appearance of one of these rounded and prominent Ends of the large Cockles, immerfed at the other in the Stone, and thus covered with its green slimy Coat, was very nearly the same with that of the round Plant growing to the Rock by its hollow or truncated Base.

It was not a Wonder that I had employ'd the Tools for loosening these from the Rock principally on such as stood on its higher Parts; nor can it be any more a Matter of Surprize that on finding those of the Protuberanes which I had thus attacked, to be the large Ends of petrified Shells, I had supposed all the others to

be such. It was not but by the Means of carrying one of the perfectest of those Plants which the Tide had cast up, in my Hand, and comparing it with the Prominences on the Rocks, that I at length found one of them to be not the End of a Shell, but such a Plant growing on it. When one has found a single Specimen of any thing of this kind, the Way to the rest is always easy: I now found that the greater Part of the Protuberances on the Bottoms of the Rocks were Plants of this kind; we tore off a very considerable Number of them, and on arriving at home put them for the Night into a Vessel of Sea-Water.

The Appearance of this Plant as it grows upon the Rock, is that of a globular Body, of the Size of an Apple, with a somewhat depressed Base: On tearing it off we discover that it is not solid, as it appears externally, but hollowed; and is in Reality not much different from an Orange, the pulpy Part of which had been taken out, and the outer yellow and inner spongy white Part of the Rind left remaining; the Outside tolerably smooth, and the inner Surface rough and fibrous; and the Cavity, in its natural Situation, always full of Sea-Water.

On examining the most perfect of those which we had brought home, it appeared that the natural Colour of the Crust was a dusky Yellow, and that the external Green was only owing to the slimy Matter extending itself over it, as

contiguous to the rest of the Rock. Of those which I had taken up from the Washings of the Sea, the greater Part were white: These had all been torn off by the Dashing of the Waves from the lower Parts of the Rocks, and the Water had washed off their adventitious Covering, and the Air at the same time bleached their internal and proper Yellow to a whitish Colour. On examining the Base of a perfect one taken from the Rock, I found that the Membranes or Crust were not continued over all that Part of the Surface of the Rocks circumscribed by the Verge of the Base; the central Part was naked, and the Plant adhered by a Rim but little thicker than its Substance in any other Place. This Rim was circularly expanded over a Space of about an Inch Diameter, and fixed down very firmly to the Rock by a Multitude of Fibres, which spread themselves to a Quarter of an Inch Distance both ways, inwardly as well as outwardly, and many of them made their Way in the manner of the Roots of the Land Plants, into the Cavities of the Stone. From this firm circular Base the Plant extends itself into a globular Form; its Height about an Inch and Quarter, its Diameter in the Middle about equal to the same Measure, and the Thickness of its Crust about a Quarter of an Inch: This is closed at the Top and on all Parts, and is perfectly hollow within.

Tho' the Surface of this appeared solid while covered with the adventitious green Matter, on the getting this off by means of Brushes, we found when the true Superfices of the Plant was exposed, that it was not so; it now appeared an elegant reticulated Matter, and on tracing its Structure from the Base we found there arose from the Rim or Verge, which was fixed down to the Rock, a multitude of slender Stems, which were furnished with Ramifications, even from their very Base, and growing up together formed the Contour of this globular Body, while their several Branches, entangling in a thousand different Directions with one another, composed a Plexus of reticulated Matter, of the Thickness of which we have already described the Crust. In some Plants this Matter was more complicated and dense, but in the most rare and open it was such as to the naked Eye had the Appearance of a tolerably compact Matter.

The outer Surface of this Crust was smooth, the Extremities of the Ramifications usually being concealed within the Texture of the Crust, but it was not thus within. The Surface of the Cavity was all over filamentous on the upper Part, and covered with a kind of Granulations below: These Granulations were of the Bigness of small Pins Heads, and occupied about one third Part of the Surface of the Crust from the Bottom; the other two Thirds were covered with these

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Ends



Ends of Filaments, which appeared extremely minute and divaricated.

The Discovery which I had made of the Fructifications in so infinitely more minute a Body as the Capsule of one of the Corallines, described in the second of these Essays, naturally led me to suspect these as the Parts of a Fructification of the same kind. The male Flowers had, in those Capsules, occupied the upper Part of the Cavity, and the Rudiments of the Fruits, or female Organs of Fructification, the lower Parts; and the fibrose Extremities of the Branches, that hung loose in the upper Part of the Cavity of this Plant, had so much the Appearance of male Flowers, and the Granulations which covered the lower of female ones, that I could not help prepossessing myself that the Fructification of this hitherto uninvestigated Plant was disclosing itself in the same Manner. The Singularity was, that the whole Plant in this Species should be destined to do the Office of the single Capsule in that: But such is the Variation of Nature on the same Principle, that this appeared in my future Researches to be really the Case.

Whether it was that the Season of the Year was now so far advanced, or that my Apparatus for Examination were less in Order, I know not, but all my Attention, tho' on a right Principle, discovered nothing during this Opportunity. I could see nothing in the Filaments of

the upper Part of the Cavity but mere naked Fibres, and nothing in the Granulations on the lower Part but shapeless Masses of Matter. One Course of Observations should never discourage the Investigator, tho' ever so fruitless, if established on a natural Plan; a thousand Accidents may hide from us at one Time, what will be obvious at another. These Attempts had been made in *September*. I was on a Visit at the same Place in the *July* of the following Year, and went prepared with a better Apparatus of Microscopes, determined to repeat the Investigation with all the Diligence and Accuracy of which I was Master. Less Resolution would have served the Purpose: The very first of the Plants which I had sent for from the same Place now disclosed the whole, and that in a Manner quite consonant with my earliest Opinion.

In order to examine one of the Plants with all due Precision, I began by cutting it perpendicularly down, in two opposite Directions: This was done with a well set Razor; and as the utmost Caution had been used not to shake or any way discompose its Contents in the doing of this, I had the Pleasure to see it divided into four Quarters, the inner Surface of each of which was as perfectly in its original Form as while the Plant was whole. The fibrose Matter, or short and minute Filaments, hung loose on all the upper Parts of these Quarters, as they had been observed in the first opened Plant, and the bot-

tom Part was in the same Manner covered with the globular Protuberances. These however did not now appear shapeless Masses of Matter, nor the other naked Fibres, as they had done before; the lower appeared evidently to be the embryo Fruit of the Plant, and the upper the Supports of the Stamina, which held the Farina or impregnating Powder.

It was easy to see that the whole Surfaces of these Fibres, which ran from the Branches, were covered with Antheræ, but they crowded so much upon one another, that neither their Form nor Situation could be seen in this View. We separated a small Part of the Extremity of one of the Ramifications, and placed it in a Concave-glass before the double Microscope with a little clear Water. It was now that the Œconomy of Nature in the Plant began to shew itself, and the Fructification to promise to explain itself.

The little Portion of the Ramification we had separated, was ornamented with no less than five of the Fibrills loaded with Farina. A slight Observation had made us suppose these no other than the Extremities of the Branches; but they now shewed themselves, in a new Light, as perfectly distinct Bodies. The Ramifications of the immediate Matter of the Plant, are of a pale yellow Colour, much like that of Box-wood, and of a striated Surface, but these were of a quite different Matter as well as Form; they arose singly from the Divisions of the Branches, and

were always inserted in the Base of the Bifurcations. They were all similar in Length and Structure, and were evidently of the Nature of those Spadices or Ears of the Palm-tree, and some other Trees which bear the male Flowers of the Vegetation, and are quite of a different Nature from the rest of the Tree.

Minute as these were in reality, each of them, under the Influence of the Microscope, appeared a Bush of about an Inch in Length, and taking in its Branches of near three quarters of an Inch in Diameter. Each arose from a single Stem, broad, flatted and smooth on the Surface: This, at about a fifth of its Height, divided into two Branches, and from each of these were produced a Number of others, the whole appearing of a light spongy Matter, and of a snow-white Colour: The Trunk itself, and the two main Branches, were naked for a little Way over, but from this both they and all the subordinate Ramifications, were loaded with Antheræ placed on Stamina, of a very singular Figure. At the Base of each of the Stamina grows a small yellowish Leaf of a triangular Form: This is very minute, but from its Bottom rises a single Stem deeply furrowed, and of a yellowish Colour. This continues single about a third of its Height, and then divides into ten Parts, each furrowed as the main Stem, and each supporting three Antheræ on its Summit.

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When the Plant is out of the Water, these fall length-ways of the Divisions of the Stamina, but when in their proper Fluid, they all are carried horizontally, and form so many Stars with three Rays: They are so numerous, that at a first View, the whole Surface appears covered with them, or indeed, formed of them, and the Fructification represents one great Puff without any Opening into its Structure. It was in vain that we stirred about the Water in order to dislodge some of the Antheræ, we found them all adhere too firmly to be thrown off in that Manner, tho' there was all the Appearance in the World that the greater Part of them were ripe.

Near the foot of the Microscope, there lay the Remainder of the Quarter of the Plant from which we had taken this Fragment, and the Surface of the Table was covered with a Powder which, on Examination, appeared to be the Globules of the Antheræ from the Stamina, within its Cavity. On examining one of the most perfect of these by the Microscope for opake Objects, we found it a very regular Body, of a rounded or globular Figure, but of a Surface far from smooth or even. On putting on a larger Magnifier, we discovered the Globule to be deeply furrowed in ten Places, in a very regular Manner, and at equal Distances: The Portions between the Furrows were rounded on their outer Surface, and the whole Globule or Anthera ve-

ry beautifully represented in Miniature the Fruit of the Hura, or as our People in *America* call it, the Sand Box-tree. The Colour of this elegant Body is a pale Red, not an absolute Flesh-Colour, but with something of a Glow of a beautiful tho' very faint Purple. While our Eyes were upon it, it suddenly vanished amidst a Cloud of Smoak or fine Dust, which we easily conceived to be the Farina, shed by its bursting. We examined many more, which sooner or later gave us the same Entertainment, and on repeating it with a very fine one placed loosely between two Plates of Talk in a Slider, under the double Microscope, we found that the general Form was not all in which the Antheræ of the Halcyonium resembled the Fruit of the Hura. The Pieces had been always lost in the former Examinations, but now that nothing could escape we found that it burst in the same Manner with that singular Fruit; and when the Dust was subsided between the Plates, we could easily see the ten Pieces into which it had separated; these had been thrown with such Violence against the Sides of the Cavity, that many of them had rebounded back into the Middle; and we easily discovered on examining farther, that the Antheræ had burst at once along all the ten Furrows, and that the separated Pieces were all open along their inner Edge, and all full of a fine and subtile Farina, that threw itself out in  
Form

Form of Dust immediately on the bursting of the whole.

We next examined the separated Globules of the Farina itself, but they were simply of an oval Figure, with nothing remarkable about them.

It was singular at first Sight, that all this Time the Branches loaded with Farina, which were kept in the Concave in Water, shewed their Globules unaltered; that while those of the rest of the Plant were fallen from their Stamina, and had, at least the greater Part of them, burst and discharged their Farina, those which were kept, as it appeared, more in a State of Nature, had gone thro' nothing of this necessary Change: But in this, as in all other natural Investigations, the farther we trace the Steps of that Power whose Hand is seen in all his Works, the more we admire them. We poured off the Waters from the Clusters of the Antheræ in the concave Glass, and exposing them to the Sun, they were no sooner dry than they all fell off and burst in the same way as the others, and this in such a precipitated Manner, and with such Confusion, that the whole was a Scene of Dust, and nothing distinct could be seen for many Minutes.

It is easy to conceive that as these were simply Clusters of male Flowers, the Plant must, in some other Part of its Cavity, produce also separate female ones; nor did the Appearance of the  
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roundish Protuberances, which covered the lower Part of the Surface, leave any room to doubt that they were these female Flowers or embryo Fruits. I had observed, that the Rocks on which I found this singular Plant growing, were all of them situated in such a Manner, that they were covered by the Sea-Water at the Time of the Flowing of the Tide, and left dry at the Ebb. It follows, that the Cavity of the Plant is successively full of Sea-Water, and empty again several Hours at a Time. While the Cavity was full of Water, the Farina discharged from the bursting Antheræ, on the Communication with which the ripening of the female Fruit depends, would probably have floated principally about the upper Part of the Water, and been applied to the Top and upper Part of the Sides of the Plant, where there are none of these embryo Fruits, none of it descending or sinking in that Fluid, so as to find the Way to the Organs which it was destined to impregnate: We find in Consequence, that while these Antheræ are immersed in Water they never separate from the Tops of the Stamina, nor ever burst at all; but when the Tide is down and they have had Time to become a little dry, they fall off, when the Cavity of the Plant is empty, and there is nothing to prevent their doing their proper Office. Their own Weight, little as it is, carries them down where there is no Current of Air to interrupt their Course; they fall strait  
upon



upon the embryo Fruits, and there burst and discharge their Farina, which has sufficient Time to perform all its Offices in the Hours that intervene, before the Tide returns and the Cavity is filled with Water.

The natural Office and Œconomy of the male Parts of the Fructification of the Plant being thus understood, it remained to examine the Female; nor is the Structure and Office of these at all less wonderful. The several Protuberances on the lower Part of the Surface of the Plant, when examined *in statu*, were found to grow regularly as the Cluster of the male Flowers, not from the Sides of the Branches at random, but from the Bases of the Divisions. We separated a fair one, and placed it before the Microscope for opake Objects; it appeared, under the Influence of a moderate Magnifier, a Lump of fleshy Matter, of a Figure approaching to round, of a corrugated Surface, and of the Bigness of the Half of a Nutmeg. On examining it closely, we discovered it to have a round thick Rim or Base, by which it adhered to the Plant, much as the Plant itself does to the Rock; and on farther and stricter Enquiry with the Help of a more powerful Glass, its whole Surface was discovered to be full of Punctures, as minute as if made by the Point of the finest Needle. We were at some Pains by Sections of several kinds and in various Directions, to discover whether the Punctures went quite thro' the  
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the Substance of the Tubercle, but we found in Consequence of these, that the Body itself consisted of two Membranes, containing between them a pulpy Matter, and that these Punctures only perforated the outer Membrane, and lost themselves in the pulpy Matter.

It was not difficult to guess, that these Apertures were destined to let in the Globules of Farina from the Antheræ, which when received in their Fall upon the Surface of these Tubercles, would be in Part at least detained by the Wrinkles on the Surface and burst upon them. We were at great Pains to search for embryo Seeds in this Cavity of the female Tubercles, but in vain. After a continued Investigation for more than a Week, we were obliged, tho' very unwilling, to give up the Point as inscrutable.

I had several of the Plants sent up to *London* and kept them in Salt-Water; some whole, others cut open, or with their Tops cut off in different Forms and Directions, and sought for Seeds from Time to Time in the more ripened Tubercles, but equally in vain. In the Course of the Time of my keeping them I saw many of the Tubercles fall off of themselves and adhere to the Sides of the Vessel. It was equally in vain that I sought for Seeds in these, but during the Time of my keeping my Observation awake upon the others, these which had fixed themselves to the Sides of the Vessel, evidently encreased in Size. This was a Circumstance  
that

that awakened all my Attention; they turned into too beautiful a State to be bursting by Accident, nor did they burst at all; they continued encreasing till some of them arrived at the Bigness of a large Pea, with the perfect Form of the parent Plant; and had not the Winter's Cold destroyed them, they would probably have grown much larger.

It appears therefore from the whole, that while so industrious in seeking after the Seeds of this singular Plant, we were seeking after what never had any Existence. Here was opened a new Scene of Vegetation, quite distinct from all that we have been before acquainted with, and answering all the Purposes of Nature, just as well as that is done by the usual Course. A Plant, instead of a Fruit containing Seeds to propagate itself by, protrudes a kind of simple Embryo, which requires all the Assistances that the separate Seeds in other Plants do, which is to be impregnated with the Principle of vegetative Life in the same Manner from the male Farina; and which, when so impregnated and fully mature, falls off; and instead of furnishing a single Sprout, that grows into a Plant as in the Seeds of others; itself expands, and by Degrees, without the Loss of any Part, its whole self becomes what the parent Vegetable was.

This is absolutely and undisputably the Process of Nature in the Propagation of this singular Plant; and to trace that back in Nature, which

which I had only an Opportunity of seeing in an Experiment. The Fact doubtless is that the Plant is an Annual; that as soon as these Embryos are at a proper State of Maturity, it perishes as the common animal Land Plants do when their Seeds are ripe, and that the Supply of the next Year is from these Embryos then let loose from their Confinement within its Body: Were it otherwise, Nature would have provided some Means for the discharging them out of the Cavity of the parent Plant, since it could answer no Purpose to have them shoot within its Circumference, but there is no such Contrivance, no Aperture in any Part at which but the minutest Body can get out otherwise than by the tearing up of the whole Plant from its Base.

When the Embryos are in a State to propagate themselves, the whole Business of the Individual is at an End; its Fibres which connect it to the Rock dry up and decay: The continued Motion of the Sea-water, assists in the shaking it off, and at length it is wholly torn up; to this is owing to the Number that at certain Seasons are seen floating on the Surface of the Sea, which happens, especially, at Autumn. The continued Motion of the Water, washes out all the Embryos, and tho' great Quantities of them are lost, a Number sufficient to continue the Species are received on the Rocks, and produce the Progeny for the succeeding Year. They become fixed, almost immediately, by  
their

their Base, by which they adhered to the Stem of the Plant to the Rock; and seemed to undergo nothing of the Change which happens to Seeds, but only encrease in Bulk till they arrive at the full Dimensions of the Plant from whose Cavity they had been separated.



**N**

**ESSAY**

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The first of these is the  
stem of the plant which is  
often found in the soil and  
is the part which is used  
for the purpose of the  
plant. It is the part which  
is the most valuable of the  
plant from which  
the oil is obtained.



E S S A Y X.

*On a peculiar Species of Insect inhabiting the  
Sea Plant of the last Essay.*

**D**IFFICULT as it had appeared to me from the beginning to trace the Organizations of the round *Alcyonium* described in the last *Essay*, and to find its Manner of Fructification, there had occurred a Circumstance, during the first Attempts toward it, that with many a Naturalist would have served the Turn of an Explication, and given Birth to a new System on this head. Among the several Specimens of the Plant, which I had caused to be preserved in Sea-water, there was one whose Surface promised some considerable Discovery, tho' the rest wanted any such Notice. While they were all perfectly smooth and uniform on the Surfaces, this was pierced with a great Number of Holes or Apertures of a regular oval Figure, but placed at irregular Distances. The Surfaces of these Cavities were too accurate to suffer them to be supposed the work of Accident or Decay; and on examining with a Magnifier,

into their Cavities, it was easy to distinguish several slender and oblong Bodies at their Bottoms, some terminating in Points, others in thicker Extremities. A Man of a warm Imagination and limited Experience, would have been ready to pronounce these so many Stamina and Stigmata; and, undoubtedly, had this Specimen fallen into the Hands of such a one, a single Observation, without a Thought of committing it to its native Element and repeating the Examination, would have ranked it among the *Octandria Hexagynia* of *Linnaeus*. The Number of the sharp and obtuse Points would have led to this Arrangement, and I could point out more than one or two of the Genera of that Author, among the Number of those not seen by his own Eyes, that have no better a Foundation.

On putting this perforated Plant, among the others, into a Vessel of Sea-water, a new and very unexpected Scene disclosed itself. After a few Minutes, the slender and erect Bodies, which had been discovered in the Bottom of the Holes, advanced their Points to the Surface, and thence, to the Height of a sixth of an Inch, above its Level, each Cluster remaining together and forming a pyramidal Body, the Base of which filled up the Mouth of the Aperture, and the Summit terminated in an irregular and obtuse Point. Here was a very new Appearance :



rance: This Plant happened to be one that had been separated with a Shiver of the Rock adhering to its Base: This had carried it to the bottom of the Water, where it stood in its natural Position, and was now armed all over with an Appearance of Spines, in such a Manner, that it very much resembled one of the round *Echini Marini*, or Sea Eggs, as they are usually called. The common round kind of these about our Shores much resembles this Plant in their Size as well as Form; and as they are frequently covered with a green Coat of the same foreign Matter with that of the Plant, the Resemblance was indeed so great, that but for the small Number of Spines in Proportion, the Mistake of one of them for the other would be easy.

I had been called away an Hour or two by some Accident from the Observation, when at my Return there was a new Face of Things presenting itself. The Surface of this Plant now appeared as free from Spines as the rest, but the Holes were still visible tho' contracted in Size, and the Surfaces of them all radiated in an elegant and regular Manner: The Rays were of a pale Red, fourteen exactly in Number to each, and those regularly disposed. These Rays took up so much Space that those from the several Apertures met in many Places, and the Plant had now quite a new Form, not appearing smooth and

green on the Superficies, but reticulated, and the Threads of the Reticulation reddish.

These Rays all lay perfectly flat and close upon the Plant, and had no other Appearance than of Ridges elevated a little above the rest of the Surface and fixed down all the way to it. On thrusting the End of a Quill toward the Plant, a new and very surprizing Scene presented itself. The Motion which the bare introducing of this had occasioned in the Water had so disturbed every Thing that before its Extremity came in Contact with any Part of the Plant, the Rays were all raised from their stellated Disposition, all collected into Clusters, and in a Moment the Plant appeared covered with distant and thick Spines as before. This Motion was as sudden and as regular as that of a Party of Soldiers with their Arms at a Review, and in a Moment more the Spines themselves disappeared, being drawn down again into their Holes, and the Plant exhibited exactly the same Appearance that it had done at the first. There could remain no Doubt of the Motion we saw being performed by animated Bodies; nor was it less palpable that these which we had seen formed into clustered Pyramids, and afterwards expanded into stellated Rays, were in Reality the Limbs of an Animal.

Unwilling to disturb the Plant for the present, we let all rest again, and procuring some of those  
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small red Worms which are frequent in Clusters in the Mud of Ponds and Rivers, and are the Food of Multitudes of the young Fish and of the Water Insects, I very softly dropped a vigorous one into the Water, immediately over the Place where the Plant lay. The Worm twisted and convoluted itself about as it descended toward the Plant: The Motion it made in the Water was twenty times more than that I had before made by the introducing the Quill, but it had a very different Effect. Nature not only alarms these Creatures on every Occasion, but she gives them Faculties to distinguish whether Danger or Advantage be near in the Incident. Instead of the sudden collecting of the Rays into inert Clusters, we now saw them all elevated a little from the Surface, but without coming near one another, all in a tremulous or vibratory Motion, and the whole Surface seemed alive and in an Extasy. Some ill Direction given to the Worm at the putting in, or perhaps its own Sense of the Danger, and Efforts to escape it, carried it a little to one Side in the Descent, and it reached the Bottom without touching any Part of the Plant in its Way. It was no sooner at Rest there, than the whole Surface of the Plant recovered its former Condition and Rest also. The Rays were expanded as at first round the Surface of the Holes, and all was quiet. I now dropped in another Worm, in such a Manner,

that it went directly down to the Plant: The Elevation and Tremulation of the Arms of the Creatures, or Rays, as they appeared, had been exactly the same during the Descent of this Worm as in the first Essay, but when it came down, it extended over so much of the Surface as to come within the Reach of four different Sets of Rays at once; they all seized upon it in different Parts, and there was some Struggle which should have the Prize: At length the Body of the Worm broke first in one Place, and afterwards in others, till each of the Series of Rays had got its separate Piece: Those of each Aperture collected themselves into separate Pyramids, and carried down their Piece of the Worm into the Cavity of the Plant. The Impatience of the rest was evident on this, they kept in a stronger vibratory Motion than before, and in several there appeared a pointed Body, quite different from the Rays themselves, exactly in the Centre of them, elevating itself a little above the Level of the Surface. After a few Moments the Series of Rays which had retracted themselves with their Prey, assumed their stellated Disposition again on the Surface, and were as busy as the rest in search of more Food.

The whole Number of the Animals were sufficiently hungry, and it afforded a very pleasing Spectacle to much Company to see them feed  
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from Time to Time, when a Worm fell within the Circle of the Rays, the way was, that that they all closed upon it at once, and instantly drew themselves down into the Cavity; when it fell only near the Verge of the Circle, one of the larger Rays or those which were obtuse, not pointed at the End, seized on it and dragged it in among the rest. Often have we seen a Worm of some Strength struggling hard to get away from the Claw of the Destroyer, or to keep itself from being drawn into the Circle; and have been Witnesses to many an obstinate Conflict between two different Rays or Arms of different Circles, the one of which had hold of one End of the Prey while the other held it by the other. Sometimes when the Body of the Worm has been too strong to break, the End of the Dispute has been the Loss of the Ray or Arm to one of the Animals. But as these Limbs are occasionally restored to the Crab and Lobster kinds, 'tis probably the same with regard to these Insects.

Tho' the Arms were not very minute, it was but an imperfect View we could have of them at that Distance and thro' the Water. The whole Animal was also to be examined, and its Form and Manner of feeding, farther than the bare catching of its Prey, remained to be known. I took the Plant out of the Water, and, determined to discover the whole History of the Creatures, cut it down vertically in half. I could  
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on the inner Surface discover nothing of the Animal kind, nothing that had any Connection with the Arms on the Surface. I began to search after more Animals by cutting down several of the Apertures with a fine Penknife, and after wounding and destroying several, as is always the Case in these Investigations where the Creatures are so minute and our Instruments, even the best of them, so clumsy, I succeeded in getting one entire out of its Cell. This we placed in a little clear Salt-Water in a concave Glass fitted to the Focus of the double Microscope, and while it recovered itself from the Discomposure into which the Operation had thrown it, examined the Cell in which it had lain. This was a very simple, but at the same time a very useful Structure. I have observed already, in speaking of the Plant, that it is composed of a ramified and fibrose Matter, covered with a Skin or Membrane of a tough greenish Matter, seeming quite different from the rest, and rather adventitious than native to the Plant. The Aperture in this green Crust was of an oval Figure, small and even at the Edges; it communicated with, or rather extended itself into a much wider Cavity, form'd in the Matter of the Crust of the Plant. This, which was the immediate Habitation of the Creature, was of an ovated but compressed Form; its Length or Depth being once and a half equal to its Breadth,  
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and that equal to twice its smaller transverse Diameter. This Cavity was tolerably smooth on the Surface, the Interstices naturally intervening between the Parts of the fibrous Contexture being filled up with a white mucous Matter from the Superficies of the Body of the Animal: The Part of it near the Crust formed a narrow Neck, and the larger Part of the Oval was at the Base. This was not perfectly even as the rest of the Superficies, but had five Depressions in it, which, like the rest of the Cavity in the whole, were narrower at their Entrance and wider within. It was easy to see that Nature in teaching the Creature to form such a Cell as this, had given it the Means of a very safe Lodging, and one where it could live at perfect Ease, tho' it did not seem possible, if the Body filled all the Cavity, that it should get out when it pleased.

From the Examination of the Cavity we proceeded to that of its Inhabitant. On casting an Eye upon the Microscope we found we had a very lively Creature to deal with: A Magnifier of small Power was first adapted to take in the whole at once; but the Motions were so violent from so many Arms at a Time, that scarce any thing was to be made out for some Minutes. At length, as it grew more languid, we had an Opportunity of informing ourselves very accurately of the Shape of its Body: This was perfectly

fectly such as filled the Cell from which we had drawn it. The Head was small and round, the Neck slender, and the Body of an oval Form, flattened, and divided at the larger Extremity into several Portions. Its whole Surface was perfectly smooth and glossy, its Frame seemingly very tender and delicate, and its Colour a White with a faint Tinge of Red.

No Eyes discovered themselves on the Head ; I believe indeed, from some other similar Observations, that the Creature, and many others of the congenial Kinds, are without them. The Rim of the whole Body was perfectly smooth and entire, till the Bottom or larger Part of the Oval, where it was deeply cut in, and divided into five Portions, each of the same Length and Diameter ; each larger at the Extremity and smaller all the way up, and all of them perfectly corresponding to the Cavities made for their Reception.

It seems a Provision of Nature that this Creature should not be liable to be drawn out of its Cell. I would not say that it has not a Power of contracting its own Dimensions at Pleasure so as to get out, but it is evident, that while the Body in general, and each of the five Divisions in particular, are larger at the Base than at the other End, and are each received into a Cavity exactly proportioned and adapted to their Size, and of a Diameter hardly equal at the  
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Mouth to half that of the Body within, it is scarce possible for any external Force to draw it out of its Hold.

The Provision which Nature has instructed the more tender of her Creatures to make for themselves is wonderful: Every Body has heard of that Species of Crab called the Hermit, whose Body is naked and defenceless, and which therefore thrusts it into some empty Shell of the Wilk or some other Species; and in the same Manner the soft and tender Head of this Insect, which would be liable to a thousand Mischiefs from any Thing almost that it touched, is secured and lodged in the Body of a Plant, in a Cavity fitted to receive it, and lined with its own soft Mucilage.

We had hitherto examined the Body of this singular Creature, in which nothing beside the Form discovered itself particular, except that the Course of the Stomach and Intestines might be in some measure seen along the Belly, and even their peristaltic Motion discovered, tho' that but faintly. We now proceeded to the Figure and Armature of its Head, which are indeed singular and amazing. The anterior Part of the Head, viewed in Front, resembles a truncated Cone, the End not perfectly even, but the Rim elevated; the Part just within the Circumference depressed, and the central Part rising again into a Protuberance, which continues it-  
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self in Form of an oblong and hollow Proboscis or Trunk, rolled up in a spiral Manner. It was the Extremity of this Trunk or Proboscis (which the Creature by contracting or unwinding the Spiral lengthens and shortens at Pleasure) that I had seen protruded up in the Centre of the Arms, by some of the most hungry of Creatures while in the Water of the Basin. This is the Organ of feeding; the Creature does not eat up its Prey, but only sucks its Juices; and it is a kind Provision of Nature, that as its Body is confined within the Cell, here is an Instrument which it extends at Pleasure to twice the Length of the Body itself, and can at other Times adapt to any Part of the Space within the Compass of the Arms. All that could be distinguished of this Trunk was, that it was hollow, and that there ran a coloured Membrane of a dusky Brown round its inner Surface.

The Arms came next under Consideration; these are fourteen in Number, and are placed in a circular Division round the Head; they take their Origin from the Surface of the Head itself, a little below that Verge or thicker Circle, which I have already mentioned, as marking the truncated Extremity of it. They are not all exactly of the same Length, tho' the Difference in that respect is not great, but they are of two very distinct kinds in regard to Figure.

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They are not like the Arms of the Polipe and many other of the minute Sea Insects, capable of being lengthened and shortened at Pleasure, but are always invariably the same in their Dimensions; and as they are the only Part of the Animal which is doomed to be exposed and out of the Cell, their Covering is much more firm and strong than that of any other Part: As the Body and Head are covered only with a soft mucous Skin, these on the contrary have a firm, and, in some Degree, a shelly Covering. They are divided by their Length, and yet more by their Form, into two Assortments; eight of them are shorter and more slender, and the other six larger and thicker: They are all jointed, but the Extremity of each of the eight smaller terminates in a single Point or Spine, while each of the six larger has a kind of Claw like that of a Lobster at its Extremity, which it opens at Pleasure, and with which it seizes its Prey.

Each of these Arms, the smaller as well as the larger, has six Joints: The smaller are not round, but compressed and angulated; their Colour is a pale Peach-Blossom Red, and they have a multitude of short stiff Hairs of a Coal-black Hue, running in longitudinal Series along them: There are about eight of these Series on each Joint, and as they stand at small Distances, the whole Leg appears hairy. The

Joints

Joints are very well formed for Motion, and are each covered with a fine white Membrane; the Extremity of the last Joint in each of these supports a Spine of considerable Length, of a Coal-black Colour and high Polish, and extremely fine and delicate at the End: This serves to inflict a mortal Wound on any Creature, while the larger holds it in its Forceps; and the Hairs along the Sides of these Legs have also their Use in detaining the Animal during its Attempts to escape.

The larger Legs are at least equal to twice the Diameter of the smaller, tho' they exceed them very little in Length; they are composed of the same Number of Joints with the others, and these are angulated and full of obtuse wart-like Protuberances, but they are not hairy as the smaller. The Claw at the Top of each of these is composed of two Parts, a larger and a smaller, each pointed very sharply at the Extremity, and each serrated all the way down the inner Side, the Tops of the Serratures being also sharp. The Creature can open this to a considerable Width and close it again very forcibly, so that a tender Insect, such as those on which it probably feeds, has no Chance for its Life after a single Gripe within this Forceps. The whole Arm in the larger has a Tinge of black over it, but the Forceps-Part is coal-black, as the Point of the former.

We threw a Worm into the Water in which this was kept, under the Microscope, to have an Opportunity of seeing it use its several Organs in feeding, but it was too far spent to attempt it: As we had Plenty of the Creatures, however, we did not give up our Designs of this Kind for this Defeat. We adapted a Microscope, with a moveable Joint, to the Top of a Frame of Wood, in the Center of which was fix'd a white Cup full of Salt Water. Into this we put four several Animals, which we had picked unhurt out of the several Parts of the Plant; and put two or three Worms at a Time among them. The Magnifier was such as would take in a large Field at once, and we were delighted with a very odd Scene. It was easy to see the Creatures were ill at Ease in their loose State; they wreath'd their Bodies about, as conscious of their Want of Defence and Covering, and for some Time seem'd in no Humour to eat; at length a Worm coming within the Reach of one of their Arms, the Creature seiz'd it greedily: The Part of the Worm which the Forceps had laid hold of, was near its Tail, it had therefore full Power to the Use of the rest of its Body, and the Sense of its Danger added to the Pain it must feel from the rude Gripe of the Paw, made it exert all that Power in Efforts for its Liberty. It wreathed and twisted itself about with great Strength, and in a Number of different Directions: and though it seem'd impossible it

should get out of the Claw, there appeared some Danger of its breaking off its own Body at the Place where it was held, and escaping with the Loss only of the hinder Part. To prevent this, the middle of the Body was seiz'd by another of the larger Claws, or Arms of the Creature, and as it now was fix'd in a Position, all the rest of the Arms were brought to bear upon it at once; and the larger all open'd their Forceps, and took hold in several Parts, while the smaller plung'd their Points into the Flesh of it.

The Struggles were now over in a Moment and the Creature dead; the larger Arms retain'd however their Hold, and bending and shaking themselves at their several Joints, they brought the Prey considerably nearer the Head than it had been at first; and the Trunks then supply'd the Place of any farther bending of those Parts: This Organ of feeding was now extended to three times its usual Length, and the End of it apply'd to one of the Wounds made by the Point of a smaller Arm. But there appears a double Use of these sharp Extremities of the Arms, they not only serve to wound and destroy the Prey, but the very Wound by which they do this, serves as an Opening, by which the Creature afterwards gets at its Juices. In all the other Insects I have seen, whose Head is arm'd with a Trunk, that Engine is pointed at the End, and qualify'd for making its own Way to the Substances on which it

it is to feed. In the several little Insects which live on the Barks of Trees, and suck their Juices, the Trunk is pointed at the End, and the Creature plunges it at Pleasure into the solid Substance, without any previous Preparation for it: in the several Water Insects also, which feed on the Juices of others, and obtain them by means of a Trunk, situated as in this Creature, that Trunk is itself a Weapon of Death, and is darted at a Stroke into the Body of the Creature that is the Prey; but in this, as the Ends of the Arms are calculated for wounding, the Trunk is suited to its simple Office of Suction, it is truncated at the Extremity, and fit only to be apply'd to a Wound already made. After some Time spent at that, to whose Orifice it had first been fixed, the Creature directed it to another of them, and so on to three or four, drawing the neighbouring Juices from each, till in about a Minute and a half nothing remain'd of the Scarlet Worm, but a thin, pellucid, or whitish Skin.

Another Worm was drop'd in after this Observation was over, and directed toward another of the Animals; as Chance would have it, not only that for which it was intended, but another also caught it by two Parts of the Body at the same Time. The Power of the Worm was nothing, for it was wounded in several Places at a Time by both at once, but the Efforts of the Creatures against one another were a Scene of considerable Entertainment.

It was now that I first saw one of the Uses of the Creatures being lodg'd in Safety in the Body of a Plant in its general Course of Nature, for being now in Want of some such Support the two that had mutually hold of the same Animal for their Prey, dragg'd one another about in a strange wild manner, and after much Hurt to both, contentedly fell to sucking it together. The several Animals of this singular Species, which were in the Plant, lived with me a great while, on being supply'd with Recruits of Salt-Water, and with no other Food that I know of, besides the Quantities of these little Worms, which I threw in occasionally amongst them. While they were with me, a Multitude of young of the same Species appear'd on the Surface of the Plant; but these being too weak to feed on the Worms, and probably not sufficiently satisfy'd with the artificial Sea-water, instead of the natural, all dy'd; how they were produced, was a Secret to me. All my Observations and Examinations were vain on this Head; and though I destroy'd a great many of the old ones in the Attempt, I could never succeed so far as to find an Embryo or Egg in any of them. This Desideratum remains in regard to so singular and beautiful an Animal, whose History is otherwise very fully known, from these Observations.



ESSAY XI.

*On a Species of Fly produced on the Flower  
of a Plant.*

**T**HE Analogy that there is between Animal and Vegetable Subſtances, is perhaps in Reality much greater than their different Forms ſuffer us to ſuppoſe. We find that after Fermentation they become much the ſame Matter, and perhaps this is not the only Proceſs that is capable of reducing them to a State of Similarity. Independently, however, of theſe artificial or accidental Changes in their Subſtance, there are ſome Approaches of them toward one another obvious to us; and there might be more if we had our Organs proper for the Diſtinctions. There are among the fungus Family ſeveral which approach to the Taſte and Qualities of the Fleſh of Animals; and even among the more perfect Plants, as they are call'd, we may trace out Inſtances of the ſame Reſemblance.

I was examining one Summer Evening the Exotick Plants preſerved in the Stoves of a Gardener near *Hammersmith*; when caſting my Eye on what is from the Smell of its Flower call'd the Carrion Plant: I order'd the Pot, in which it ſtood, to be brought near the Noſes of ſome of the Company, that they might be convinced how very nearly the Smell of a Flower, in its full Glory, and ſtrongeſt Period of Life,

can resemble the decay'd and stinking Carcass of an Animal. On examining two or three other Species of the same Genus, that were then in Flower, I found that this singular and offensive Smell was not confin'd solely to that usually nam'd from it; I found another that possess'd it in scarce a less Degree. It appear'd singular to the People who were with me, that instead of the usual Perfume of the Flowers of Vegetables, there should be some that had this abominable, and, as it appear'd, unnatural Stink; but we were soon convinc'd, that it was not Fancy that gave us the Idea of the Carrion Smell. A Creature of much finer Organs than our own, and much more interested in the Accuracy of the Resemblance, convinced us we were right. While we were looking upon the last mention'd Plant, a Fly of the same Genus with those which lay their Eggs in putrid Meat, but of a much more beautiful Species than the common Kinds, attracted by the Carrion Smell, fix'd upon one of the Petals or Leaves of the Flower, and in our Sight began to deposit her Eggs in regular Series, and considerable Numbers upon it. I do not recollect to have been of a long Time more struck by any thing than by this Observation. I order'd the Pot with the Plant in it to be set by in a Corner of the Place, where more Flies might if they pleas'd come at it, and after two or three Days to be carefully sent to me.

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My Expectations in this were not disappointed. When it arriv'd in Town, it was easily seen that more than one or two, that several Females had visited it with the same Purpose; but as the Eggs were all perfectly similar, it appear'd very plainly that they had been all of the same Species.

Had they been only of the common simple Form, round, oblong or oval, it would have been easy to mistake this; and indeed among several Species of the common Flies the Eggs are so perfectly similar, that there is no Saying, on the Sight of a Number together, whether they are the Produce of one or more Kinds; but as if it had been decreed, that in so singular an Instance as this, the Œconomy of Nature should not be hid, there appear'd a Singularity in the very Form of the Eggs, that made it impossible to mistake them for any other, or to confound those of any other Fly with them. The Flower of the Plant on which they were deposited, was of a deep red and large; they were placed in square Phalanges as it were on it, and were of a fine pearly white, of a glossy Surface, and seem'd so many Gems studded on the Surface: they were of an oblong Figure, and what was particular, they were not laid lengthwise, but all stood erect at one End. It seem'd at first strange, that they kept that Position, but on taking one of them off, the Mystery was explain'd. At the lower End of each Egg, there stood out a Pair of Horns as it

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were, two fine slender white pointed Bodies: these evidently contain'd no Part of the Matter of the Egg, but were only contiguous with the Shell, or outer Coat of it. The Petals or Leaves of the Flower, on which the Eggs were plac'd, were not so thin and delicate as in many Species of Plants, but firm, and in some Degree juicy, consisting of two Membranes, and an apparent gelatinous Matter between them. The Creature, as it deposited the Eggs, always discharg'd them out of her Body with this forked End downwards; and by the forcing Motion of her Tail, as she deliver'd them, infix'd these two Points into the Substance of the Flower: they every where on Examination were found to pierce through the upper Membrane, and penetrate into the Parenchyma.

By this Means the Eggs were all fix'd, erect and near one another; and the Moisture of the pulpy Part of the Flower seem'd to communicate itself to them some Way by this Means, for their Outsides kept all over more unctuous and glossy than I ever saw in the Eggs of any other Species. It was palpable, that the Smell of the Flower, similar to that of Flesh when in a Condition to afford Nourishment to the Produce of the Eggs of Flies, had brought the Parent Animal to it, in order to provide as well for her young, as if deposited on Flesh, nor did there appear any doubt, but that the Juices of the Flower wou'd be as similar to those of putrifying Meat as was the Smell: but there remain'd

main'd a Question, even supposing them a proper Nourishment, how the Creatures wou'd find enough of it, since the Duration of the Flowers of Plants is so limited. Nature however had provided as well for this as for all the other seeming Objections against her Oeconomy; and as the Substance which was to afford Nourishment to the Produce of these Eggs was of shorter Duration than that on which the other similar Productions feed; this Creature was proportionably a shorter Time in the Egg, and in the Worm or eating State, than any other. The compleat Period from the depositing of the Egg out of the Body of the Female to the Production of a compleat and perfect wing'd Insect like herself, is indeed twenty-three Days in this Species, but almost the whole of this is spent in the Aurelia or Nympha State, in which no Food is necessary; and the Period of the Egg, and of the moving and feeding Worm comes within that of the Duration of the Flower.

I had made it an Observation while in the Stove where the Plant originally stood, that the Carrion Smell of the Flower was much stronger in those which were just opening from the Bud, and by degrees grew fainter in the others. This tempted the Female Flies that were about, to deposit their Eggs on the Flowers in that peculiar State preferably to the others; and such as were in that State had a Time to stand,  
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that perfectly answer'd to all the Purposes of the Animal.

It would have been difficult for me to have had the several Periods with Exactness from those Eggs, which had been lodg'd on the Flower before the Plant was sent to me; but Fortune favour'd the Investigation more than I cou'd have conceiv'd; a fine Bud began to open on the second Day after the Arrival of the Plant at my House. I had set it in the middle of the Day out at a Window for Air, and I had the Pleasure very soon to see two Female Flies of the same Species, which I had seen lay on it in the Stove, now settle upon the opening Bud, and begin the same Operation at my Window. This appear'd the more singular, as I had never seen the Species before: but I was very happy to have such an Opportunity of tracing the whole Progress of so uncommon an Incident in the Animal World in all its Branches. It was about Four in the Afternoon that these Eggs were laid on the Flower, and by Eight the following Evening they were all hatched. The Worms produced from them instantly began eating; they made their Way thro' the upper Membrane, and devour'd the pulpy Matter of the Petal; but whether the Quantity is naturally very considerable, or whether Nature recruits it from their Wounds, so it was that the Flower, though mangled in a strange Manner, continu'd vigorous and juicy five Days longer.

longer. At the End of this Time it grew flaccid, and the Worms became more unweildy in their Motions, at length they fell off from it, and crawl'd slowly upon the Earth about the Bottom of the Plant, without any Attempt to get upon it again. The next Morning I perceived they were browner than before; this Colour encreased upon them, their Head lost its Smallness, and before the Evening of the same Day, they were all in the Nympha, or Chrysalis State.

It is the Custom of many of the Animals of the wing'd Tribe, to bury themselves at the Approach to this State of Rest, in the Earth; and I was in some Pain for fear an Omission of, or want of Health and Vigour in these Worms, might have robb'd me of the expected Pleasure, of examining the Fly in its perfect State. I saw by the slight Observation of the present Animal, during her laying the Eggs, that it was a Species very worthy the Attention of the Naturalist, and might have caught her; but there is no State in which the wing'd Insects in general are so perfect, or so fit for Observation, as when just produced from the Chrysalis. It is not with them as with Animals produc'd from Eggs, which are small and insignificant, and after grow to their Maturity; all this is done in the winged Tribes during the Worm State, and that Time of Rest which is spent in the Chrysalis, and the Creature is produc'd from that Shell or Case at once in its full Perfection, and at its  
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destin'd Size. The Parts are indeed wet, and the Wings folded and crumpled together, but they are no sooner expanded, and the whole Animal dry, than it is in a State of Perfection, after which every Accident injures, but nothing can improve its Beauty. It is on this Plan that the Reader will always find me deferring my Observations on the perfect Animal in these Species till the Production of it, in Consequence of my Care in its reptile Form. But in this singular Instance, it may be proper to give some Account of the preparatory State of that of the Reptile, produc'd first upon the Petals of the Flower.

The Worm always made its Way out at the upper End of the Egg, and that by gnawing a Hole through it, for which Nature had very well provided it; the same Organs answering that Purpose, which served afterwards for its feeding. When first escap'd from the Egg it is very minute, but it quickly arrives at its full Size, which is about the fifth of an Inch in Length, and a tolerable Thickness in Proportion. Its Colour is a fine pearly white, like that of the Egg from which it is produced, but its Body is annulated or form'd into a Number of Rings, about twelve, and the Cartilages which join these to one another, are round, prominent, thick like Cords, and of a dead or duller white than the rest. The Head is very small and sharp; the opposite Extremity is thicker than any other Part of the Body; indeed



deed from the very Summit of the Head to the opposite End, the Body all the Way encreases gradually in Thickness; at the larger Extremity the Creature appears truncated. The Verge is surrounded by a thick white Ring, like one of the Cartilages which join the Rings of the Body, and there are two Apertures or round Holes near its upper Part, each surrounded with a thick Cluster of minute Hairs, probably to prevent any thing from getting into them. These are the posterior Orifices of Respiration, and there are two other, the anterior ones, situated on the upper Part of the third Division of the Body; for these Insects in this State do not breathe by the Mouth, as other Animals do, but always by some such extraordinary Apertures. We are to consider, that the Body of the future winged Animal is all the while within this Case, and in a Manner independant of it. The Organs of Eating necessary to the Worm, are not continued to the Fly, but are of the Number of the Parts cast off in the Change, consequently tho' there be a Communication for the nutritive Juices of the Food between the Mouth of the Worm and the inclosed Animal. The Matter of Respiration however necessary to it, may be carry'd on by Organs quite unconnected with that Apparatus. The small and pointed Extremity of the Head of the Worm was furnish'd with an Apparatus for Eating, consisting of two sharp and solid Teeth of a brown Colour, which it thrust forth at the Opening  
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of the Mouth, or retracted at its Pleasure, and with which it tore its Way out of the Shell, and afterwards thro' the Membrane of the Petal or Leaf of the Flower, into the pulpy Substance.

Such was the Figure of the Worm during the Period of its Eating. The feeding of these Creatures is only during a limited Time, the whole is destin'd to the nourishing the included Animal to a certain Pitch; and when that is done, notwithstanding there be ever such Plenty of Food, the Reptile devours no more, but prepares for a State of Rest either under the Covert of a Case of its own framing, or a thick Web of its Spinning, as in the Caterpillar and Silkworm Kind; or else under the more plain and simple Apparatus of a Shell form'd of its own harden'd Skin in which it undergoes, no one can conceive how, the Change into the perfect Animal.

When these Worms drop'd from the Flower, whence they had hitherto been nourished, I knew the Time of this Change was coming on; and it was easy to guess, that as the Creature was of the Maggot Kind, the Change was to be under a Shell form'd only of its Skin. The Head drew up after a few Hours crawling, and what appear'd more singular, the opposite Extremity, instead of its truncated, assum'd a spherical Form. The Rings of the Body became more prominent, and their intermediate Spaces more contracted, and the whole, beside its  
Change

Change of Colour into a deep Chestnut brown, became instead of an oblong, and in some Degree conic Body, an oval one, nearly equally thick at both Ends. The Marks of the Apertures for breathing remain'd distinct at both Ends; and undoubtedly whatever be the State of the unform'd Insect within, they continue of Use to it in that Form. What was most singular in this Shell was, that there was a thin Place toward that End where the Head of the Worm had been, out at which it was probable the Creature in its winged State was to make its Way, and a Pair of short Protuberances, like Horns or Ears, stood out from this Extremity, which had not been seen in any other State of the Animal.

As I had a considerable Number of these Chrysalis's, I determin'd to watch the Progress of the wing'd Insect in them from Time to Time. I reckon'd that the Change could not be a very long Time in coming on, and devoted one a Day to Destruction, in order to the tracing the Motions of Nature in this strange Metamorphosis, as Ignorance has been used to call it. I had promis'd myself great Matters from this Investigation; but I was thoroughly disappointed. That which I open'd on the first Day, contain'd only a Quantity of white fluid Matter like Cream; that which I open'd on the second, contain'd just the same; and so on to the twelfth: at which Time I had destroy'd as many as I thought proper to spare in the vain  
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Enquiry, without finding any Change in the Matter of their Contents, any Approach toward the Form of a wing'd Animal, like that which had deposited the Egg, or indeed any Alteration from the State of the simple Fluid I had seen in the first.

After I had some Days despair'd of any Fruit of my Pains, and given up the few remaining Chrysalis's as lost by some Accident for want of sufficient Food, for the Impropropriety of that Food by the Error of the Parent Animal, or for want of the Shelter of the Earth in burying them: I had the Pleasure to see what I little expected, which was a Motion of Elevation and Tremulation in the thin Part of the Shell of one of them, which I mention'd near that Part where the Head of the Worm stood. I watch'd the Issue of this with a small Magnifier in my Hand, and it was not many Minutes before I saw this thin Part, which seem'd rather a Shell or Covering of an Aperture connected with the rest of the Case than any regular Part of it, begin to loosen at its Top, from the thicker Substance to which it adher'd: the Efforts from within were now redoubled evidently from this Promise of Success, and in a little more Time the Opening enlarg'd both Ways, and by Degrees the Shell became loose at all its Edges, and in Consequence of one Effort more, fell off.

Here was now an Opening into the Cavity of the Shell, and there appear'd at it a solid Lump of an oval Form, endu'd with Life, and alternately

nately distending and contracting itself. I took this to be the Head of the Fly, but was surprized to find no Traces of Eyes, Antennæ, or other Parts of a Head about it; all that the best Power of a single Glass offer'd to view was, that it was of an irregular Surface and hairy. The Motions of Dilatation and Contraction in this Part continued, and it was evident enough that they were owing to Respiration, and consequently the immediate Necessity of the Apertures for breathing in the very deadeft appearing State of the Chrysalis was evident, since it was equally plain that it was to these Motions the Creature had ow'd its first Approaches toward Liberty, in the forcing off of the Covering of the Aperture, at which it was now about to escape from its Confinement.

The Motion continued and encreased till the anterior Part of the Shell was forced downward, and at the same Time a Crack or Fissure appear'd on the Back of the Shell or Coat, beginning at the Centre of the Opening made by the falling off of the Piece, and extending at least half down the Back. As this very soon grew wider, there appear'd a sufficient Opening for the whole Insect to come out. The Opportunity was not neglected, the Creature forc'd itself forward, till the Body and at length the Thighs of the hinder Legs appear'd, these seem'd to have been principally concern'd in the pushing the Creature up, and consequently the whole was now in a Manner over; the four an-

terior Legs began to exert themselves, and by their Means the whole Creature was seen at Liberty, crawling as it were out of the Case in which it had pass'd so many Days of Rest and Darknefs.

I receiv'd the unwieldy, and oddly moving Animal on a Sheet of white Paper, and examining it at the Light, and with the Assistance of Glassess, could discover nothing more of it than that it was a kind of shapeless Lump of animated Matter. It was of an oblong Form, and had six Legs which were all in Motion, and its Body was also distended and contracted as from the first at short Intervals, but nothing more of the Creature appear'd. What I had at first taken for the Head I now very plainly discover'd to be the Breast or Thorax, and was not without Suspicion, that the Head had been torn off, and by some Accident left behind in the Shell. This, however, was but the Suspicion of a few Minutes, the Parts as yet invisible soon appear'd, and to an Eye not accusom'd to the Processes of Nature, would have seem'd created after the Exclusion. There was all the Appearance in the World that the most essential Parts of the Animal grew out of the rest, after the Production of the more massy Ones from the Case or Shell.

As the several Parts of the Fly are not of Use to it till after the Exclusion into the open Air, and as Nature has allotted the whole to be lodg'd till that Time in a very narrow Compass; they

they are folded together and plaited, and lodg'd upon, about, and within one another in a very remarkable Manner. The anterior Extremity of the Thorax of the Fly, had at its first Production from the Shell appear'd truncated and even: But in Consequence of several of those repeated Distentions, to which the original Exclusion had been owing, the Points of two short and slender Hairs appear'd protruding themselves from its oval Surface. The thicker but oblong Bodies, from whose Extremities these grew, next forc'd themselves out, and it was evident to an accusom'd Eye, that they were the Antennæ of a two wing'd Fly; next presented themselves the anterior Surfaces of two chequer'd Orbs, which were plainly the complex Eyes of an Insect of the same Species, separated by a plain Portion of a Forehead; and soon after the whole Head. This was no sooner all in View, than it swell'd to a Diameter equal to twice the Measure of that of the Breast. It might have appear'd from the first, that the Head was growing under the Eye of the Observer, from the Extremity of the Thorax, but tho' a more rational Enquiry could not but produce for its Answer, that it was only now thrust forth out of the Cavity of the Breast in which it had before been lodg'd; it yet appear'd singular after this sudden Change in Size to conceive how a Thing should have been till that Moment lodg'd in a Cavity not equal to half its own Diameter.

The Head was now entire and in its Place, and the Legs were firm, and supported the Body well, but the Wings did not yet appear. On examining the Place where they were to be expected, I discover'd two irregular Protuberances of a wrinkled Surface, and considerably large, and under them the two oblong Pedicels which we see supporting the Balls under the Wings of all the two wing'd Flies. It was evident from this, that the Protuberances at the two Sides of the Base of the Thorax were the very Wings in their folded State, and this was soon prov'd by their expanding. The Wings in all this Race of Creatures are the last Part that appear after the Exclusion from the Chrysalis: they are by far the most delicate Part of the whole Frame; nor is it a Wonder that when folded together in so small a Compass, there should require some time for their expanding. As my Eye was upon them, their Creases and Wrinkles began to unfold, their Volume to extend, and their Colour to become paler. I never saw so amazing a Process: even to me who was prepar'd for it, and perfectly knew what it was, they appear'd to grow from the Place of their Origin in this sudden Manner. There was some Time taken for the full Explication; but it was a most surprizing Thing to see two irregular Globules, not larger than the Heads of Pins, expanding into a Length and Breadth more than equal to the whole Body of the Animal. When fully open, they



they cross'd one another over the Creature's Back, and extended to a considerable Distance beyond the Extremity of the Tail.

The Time of my final Observation on this Insect was now come. The Creature was in its Perfection: It began to vibrate its Wings, and the Fear of its injuring its own delicate Form, added to that of its flying away, made it necessary for me to secure the Means of my Examination by its Death. 'Tis a cruel Price we pay to these Investigations, when the Creature that is to furnish out the Entertainment, is made to pay its own Life as the Condition. I have often felt a Pain at thus destroying the Individual, to acquire a Knowledge of the Species; and if there were not something more to be said in favour of it than the bare Desire of Knowledge, I don't know that it wou'd be justifiable. As it is necessary to kill the Object of Observation in these Cases, I always have the Mercy to do it instantly; a Needle, the Point of which had been dip'd in Aqua fortis, was thrust thro' the Breast of the Creature, and it was fix'd to a Piece of Cork, for the Convenience of turning it about for Examination.

This Insect, though large enough to offer its Beauties to the naked Eye, yet is of a delicate Form and Colouring, that the Advantage of a Magnifier of small Power, adds greatly to the Observation. It is about equal to the common blue Flesh Fly in Length, but its Body is of a very different Form, and not nearly equal to

it in Thickness; it is much narrower in Proportion to its Length, and is of a flatted Form, somewhat round on the Back, hollow on the Belly, and obtuse at the Extremity.

The Head is remarkably large, and appears horn'd, the Antennæ being short and thick, and protended directly forward. The Head is of an elliptick Figure, and plac'd transversely to the Body; its Diameter from Side to Side being at least once and an half as much as that from the Front to the Back. The Beauty of the whole Insect is scarce to be described. The Horns, or Antennæ, have their Origin close together at the middle of the Head, and separate to a greater Distance all the Way to their Points. They are compos'd each of a short Pedicle, a single oval Joint, and a Hair or Bristle. The Pedicle is of a blood red Colour, and is slender and polish'd on the Surface. The Joint is of an oval Form, and considerably thick. It is of an elegantly channell'd or furrow'd Surface, like that of a fluted Column, the Furrows placed at some small Distance, and the Ribs between them rounded extremely smooth and glossy. The Colour of this Joint is an elegant and strong blue, perfectly like that of the Body of the common Flesh Fly. The Microscope discovers three Rows of Punctures running along the hollow of each of the flutings of it, one in the Middle, and one on each Side at some little Distance: it requires a very powerful Magnifier to distinguish these, but they are  
not

not singular in this Species, I have discover'd them in the Flutings of the jointed Antennæ of some others, and am not without Hope that they may sometime tend to the explaining the hitherto unknown Use of these Organs. The Hair which terminates each Antenna grows from the Summit of the Joint, and that not from its Centre, but from its outer Edge, it is equal to once and a half of the Length of the Joint, and is considerably thick and stiff, and appears rather a Segment of a Bristle than a fine Hair. Its Surface is very bright and glossy, and its Colour a deep black. The whole Antenna, when view'd together, appears of a purplish Colour, by some odd blending of the Shades of the three distinct Colours; but when view'd more accurately, it appears very beautiful in the regular Distinction of the Colours, which are very different from one another, and all strong and beautiful in their Kind.

The Eyes in many Species of the Fly Kind occupy almost the whole Surface of the Head, but it is not so in this Species. This is not that they are small, but the Head itself is larger in its transverse Direction than in most other Species. There is a tolerably broad Space between them, in which are inserted the Antennæ, and even beyond them on each Side, as well as above and below them, more of the naked Surface of the Head is seen, so that tho' large they appear, not forming the whole Contour of the Head, but set in Sockets at its Sides. All this naked

Part of the Head is of a very beautiful Purple, the Colour is deep and changeable, so that it appears very different as seen in different Lights, and it is furnish'd with a few short and stiff Hairs of a Coal black, which in the general give a Duskynefs to the Colour. The Eyes themselves are of the Figure of half a Globe, they are form'd of a beautiful Kind of Lattice Work, or cut into small Facets all over their Surface in the Manner of a multiplying Glass, the Lines serving as the Divisions being very fine and small. It is owing to this Structure, that the Eye of this, and a Multitude of other Insects, is compos'd of a vast Number of more minute Eyes; and it must see at small Distances every Way around it at once, and with great Precision. Nature has so provided for this little Tribe, that they see their Food multiply'd into many Portions, and a thousand Objects of Danger in the Place of one. The Colour of these Eyes is very beautiful, and very variable; they look extremely different in different Lights; and as their globular Figure catches the Light in very different Directions, the Variation is almost endless. The more distinct Colours are a coppery red and a pale green. In many Lights they resemble those Silks of a changeable Colour, which are purple and green; but in some they look only of a fine bright yellowish green, and in others almost entirely of a fiery red. Their whole Appearance is extremely bright and glossy, and their Beauty not to be imitated by the  
Pencil,

Pencil, and hardly to be described by Words. In the broad Area, which runs down between these Eyes, or in the Front of the Head, a little below the Origin of the Antennæ, there stand three small lucid Protuberances. They are very minute, of a glossy Surface and coal-black Figure, and of a hemispherick Form. They stand in Form of a Triangle, and are remarkably conspicuous. These are indisputably three Eyes, single, quite different from the complex ones, which occupy the Sides of the Head. They are form'd like those of Land Animals; and as the others are calculated for viewing near Objects, these are indisputably form'd for seeing at a Distance.

The Thorax of this Insect is of a very singular Form and Appearance; it is in Length more than equal to the transverse Diameter of the Head, but not in Breadth, and it is connected by a broad Extremity at one End to the back Part of the Head, and at the other to the upper Part of the Body. It is very thick, and its Figure singular; it is depress and broad on the Back, but very prominent or full on the under Side, and from it grow six Legs, all towards its Base, and their Originations very near to one another. The upper Part of the Thorax is not more different from the under in Form than it is in Colour; it is of the brightest and most elegant green imaginable, with a Tinge of brassy yellow diffus'd all over it. The *East Indians* have a Way of gilding with what they call

call green Gold; that in some faint Degree comes up to this Colour; but those who have not examin'd the Backs of some of the Fly and Beetle Kind, can form no Idea from Words of the amazing Lustre of these singular Combinations of Colours. The green is not a deep, tho' an extremely full and strong Colour; and this seems the ground Tinge, the brassy yellow is more or less visible, according to the different Light in which it is view'd, in some scarce distinguishable, in others almost the principal Colour. The whole has a Metalline Appearance, and the Surface of the Back itself is so smooth and glossy, that the Eye can hardly bear to look upon the Polish, animated by such glowing Colours. This whole Surface is hairy also, which gives a strange Variation of the Colour in some Lights. The Hairs do not stand very close, but they are moderately long, somewhat stiff, of a deep glossy black Colour, and all of them bend backwards.

Tho' the whole upper Surface of the Thorax be of this Colouring, on Appearance it is so different from the rest, and so distinctively confin'd to its own Limits, that it appears not as the Surface of the Body itself, but as a polished Shield of this Appearance thrown over the upper Part of the Thorax; the Sides and the whole under Part are perfectly different from this; they are not of this high polish'd Appearance, nor have any Tinge of either green or yellow. They are rounded and prominent, and the Breast also is still more prominent on the Under-part.

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The whole has a fleshy Appearance, its Surface is irregular, and its Colour a very pale red like that of the Peach Blossom. It is all over hairy, but the Hairs are finer, shorter, and more delicate than those on the Upper-part, and have each a kind of Papilla or little Prominence at their Base; they are of a deep black Colour, and stand closer than those on the upper Surface, they all bend backward also. When the Creature is viewed in a front Light and Situation, the Sides and lower Part of the Thorax appear of a flesh Colour, and the Hairs black, but when seen Sideways, and especially when from behind, the Black of the Hairs, has an Effect upon the Colour of the under Surface, and renders it obscure and purplish.

The Legs are remarkably robust and long for the Size of the Creature, the hinder Pair are largest, the two anterior Pairs are nearly of an equal Length, the Structure is the same in all. Each is form'd of three Joints, the upper one is that next the Body thick and angulated. The second somewhat more slender and flatted, and the extreme one slender and angulated. The two upper Joints are of a very deep and dusky Purple approaching to black, the last or lowest Joint is absolutely black. The upper Joint is covered very thick with Hairs, they are fine and soft, and all of them point downwards, the second Joint is also hairy, but in a very different Manner. The Hairs on this are very few, not more than ten or a dozen in the whole; they  
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are of a glossy Surface and Coal black Colour, and appear rather as Bristles than Hairs. They do not point downwards as those of the upper Joint, but stand out strait and horizontally. The last or lowest Joint has but few Hairs upon it also, and these are thick and black, but they are very short, and point downward. The Extremity of this Joint is bifid or divided into two Portions resembling Claws, these are very sharp, and are hooked, and have a globular spongy Substance between them. Their Points are so extremely fine, that they must be capable of piercing into almost any Thing the Creature pleases.

The Body of the Fly is of a singular Form, it is long and flatted, it does not run strait from the Top at the Thorax to the Extremity, but is somewhat hooked or bent downward, so that the Under-part appears hollow. The Upper-part or Back is depressed, and nearly flat or plain, but it has a little rising in the middle. The Under-part or Belly is also a little prominent in the middle, but it is again hollow'd between that and the Sides, and at the very Edges has a prominent Shell all the Way along. It is cover'd with a kind of Mail or firm Armour, divided into nine Joints by transverse Rings, and beside this is defended by the Wings, which are so large that they cover it entirely, as the Creature is in a Posture of Rest, and reach over its Verge both at the End and Sides. The Colour of the Mail on the Hair is a bright and beautiful  
Purple,



Purple, and the whole Surface is of so high and elegant a Polish, that nothing can give any Idea of its Brightness except the polish'd Surface of some Metal. The Sword Hilt which the King wears in Time of Mourning, and which is of what the Workmen call sanguin'd Steel, comes the nearest of any Thing to the glaring Colour and metalline Gloss of this Part of the Fly, but is vastly inferior to it in Beauty.

The transverse Lines which part the several Rings or Joints of this Male are not purple but blue, and that of a strong and elegant Tinge, so that there is a very beautiful Variegation form'd in the Colouring of the Surface by this Circumstance. The whole Surface also is thick, cover'd with Hairs; these are short and black, and all stand in a reclining Posture, their Points turn'd backward. These cover the Body so closely, that they in many Lights greatly influence the Colouring, and render the Purple deeper, and in some almost quite black.

The Belly of the Fly is throughout of the same elegant blue, with the Divisions of the Back; this is a very bright and glossy Colour, and has somewhat of the metalline Tinge of all the rest, which is correspondent in a great Measure to the high Polish of the Surface. This blue is somewhat like that of the Body of the common blue Flesh Fly but a little paler, it more nearly indeed comes up to that in the Wing of the common Jay. The whole Surface of the Belly is hairy, as well as that of  
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the Back, and the Hairs are also black, but they are longer, and are less bent backward than in that Part. The last Ring of the Body is somewhat smaller than the rest, and is also smaller at the Extremity than at the Base, but it there does not terminate in a Point, but is obtuse and rounded. This Ring is drawn down more than any other, and is indeed almost of a hooked Form, and this seems the Provision of Nature in the Male, for the more easy Impregnation of the Female, and in that Sex for the more convenient depositing of the Eggs.

The Wings are the only Part of the Insect that remain to be examin'd; they are of a very singular Length and Size. I have observ'd that the Body of the Insect is long in Proportion to its Breadth, but these are considerably longer. They are only two in Number, they have their Origin from the hinder Part of the Thorax, and in the usual Position in a State of Rest, are carried straight back over the Body, and reach beyond the Tail; they lie upon one another in this Position, and form a Figure whose Angle is three Times equal to its Breadth, its transverse Measure nearly equal all the Way, except that it is a little narrower towards the Base than elsewhere, and the Extremity rounded.

The Wing examin'd separately, is of a fine thin Texture like Gauze; its Colour is of a pale brown, it is perfectly transparent, and is supported all round the Edges by strong Ribs, and has several other such running obliquely over it,  
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taking their Origin from the outer or thicker Rim, and terminating near the inner or smaller. All round the Wing there runs a Circle of small round Spots of a deep black, and on the outer Edge there run within this two other Series of smaller Spots, but these are not distinguishable without the Assistance of a Microscope.

At the Base of each Wing there stands what the Naturalists calls a Balancer, this is a flat and cylindrick Pedicle of a brown Colour, having an oval Protuberance at its Head. This is common to all the Flies which have but two Wings, and as it is peculiar to those, it seems to stand in some Degree in the Place of the inner Wings of those which have four.

The several other Insects of the same Species, which were produced from the other Chrysalises which I had spar'd, were in all Points like this, except that such of them as were of the other Sex, had the last Joint of their Bodies more bent downward, and a little smaller at the Extremity, tho' in these it did not terminate in a Point. I suffer'd these to fly at Liberty about the Room, but was at some Pains to find the Means of preventing their Escape out of it. They leap'd in the Sunshine, and seem'd to draw Vigour and Strength from its Beams. The Time of this perfect State in the winged Form, is generally very short in the Insect Tribe. There are many Species which live only a few Hours in it; that suppos'd singular Kind call'd from its always dying on the same Day in which it is produc'd  
from

from the Chrysalis, the Ephemeron, or Fly of one Day, lives two Years in form of a Worm under Water, and in all that Time eats, and in every respect enjoys its Being. 'Tis so in a greater or less Degree in all: The Caterpillar is much longer liv'd than the pompous Fly produc'd from it; and the Cossus, or Worm of the Tree Beetle, enjoys itself two or three Years in that State, tho' its whole Period, when it has assum'd its wing'd Form, is only of a few Months. The principal End of the Existence under this ultimate State is, indeed in most, merely the Propagation of their Species; and many of them are so evidently calculated for nothing more, that they have not any Organs in it for eating. That is not exactly the Case with the Fly, which has been the Subject of this Essay, it is provided with the Organs for this Purpose, wholly like those of the common blue Flesh Fly: But one of the first Businesses of Life I soon saw was the Impregnation and Propagation of the Species. The Flies which were loose in the Room soon coupled with one another.

I had yet the Curiosity to satisfy of their manner of breeding. I open'd one Female before her Impregnation, and was surpriz'd at the vast Number of Eggs of their full Size, which she had brought into the World with her. The whole protuberant Part of the Body was full of them, they were of the same exact Figure with those which had been deposited in the Flower of the Plant, from which all these had been produc'd,

produced, and seem'd connected together originally into a broad and flat Mass, which was roll'd up into a cylindrick Form, and fill'd the whole Cavity of the Body.

In those which had been impregnated by the Males, I saw no other Change than that the lower Part of the cylindrick Roll of Eggs, or that which was next the Aperture at which they were to be discharg'd, became more loose. The Plant, from whose Flowers the Offspring of the former Eggs had been fed, did not now produce any more for me, or if it had, that would not have answer'd my Purpose. The Business was now to know, whether the Flower of that Plant was the peculiar and appropriated Food of the Worm of these Flies, as is the Case in regard to the several Caterpillar Kinds, the Eggs for the Production of which are deposited by the Parent Animal only on that distinct and particular Plant, which will afford a proper Food for the Reptile; or whether the mere Resemblance of the Juices of that Flower to those of putrifying animal Substances, had led the Females of this Species, charg'd with Eggs, and not immediately discovering any of the other, to deposit them on it.

I brought into the Room several Pieces of Meat, which had been kept two Days, and the Event of the Experiment fully and exactly answer'd my Expectation. The Females all flew instantly to the Meat, and deposited

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their Eggs on its Surface, just as they had done on the Petals of the Flower. What was more singular was, that as I had delay'd the bringing in of the Meat a little too long, some of them deposited on it young living Worms instead of Eggs, the Eggs having hatch'd in their Bodies, which had retain'd them beyond their destin'd Time, for want of a proper Matter to receive them, and to afford Support for their Produce.

I watched the Eggs, thus deposited on the Pieces of Meat, thro' all their Changes, as carefully as I had done those which had been laid upon the Flower. The Progress was in all Respects the same in both Cases; and I had Flies as beautiful, and as perfect produc'd in due Time, from the one as the other. It is evident from this, that there is a strange Similarity not only in Smell, but in the real Properties and Qualities of this Flower and of the Flesh of Animals; and I make no doubt but future Experiments will prove that it will yield the same Principles on a Chemical Analysis.

E S S A Y XII.

*On the Production and Fructification of a singular Species of Moss.*

**T**HERE is no Object so apparently inconsiderable, that has not something to invite the curious Eye to examine it; nor is there one, the Examination of which with the proper Advantages, does not amply repay the Trouble of the Investigation. We owe a vast deal of the Pride of these Discoveries to the Power of the Microscope; but we are in the Wrong, when we suppose the Creator of all Things intended to hide the Objects from our Observation. It is true, that the Use of this Instrument discovers as it were a new Creation to us; new Series of Animals, new Forests of Vegetables; but he who gave Being to these, gave us also Understandings capable of devising Means to assist our Organs in the Discovery of their Beauties. He gave us Eyes adapted to our Use to the enlarging of our Ideas. He form'd them such as should comprehend in a Manner an Universe at one View; and while he fashion'd them on this Plan, and consequently incapable of discerning the minuter Creatures with which he had peopled every Atom of that Universe, he gave Properties and Qualities to Matters of various Kinds, capable of giving

us occasionally those Advantages, which we could not otherwise have had, unless at a Price more than they were worth; and he gave us at the same Time a Power of Understanding equal to the Task of rising, from one Degree of Knowledge to another, till we should arrive at the giving ourselves these Assistances.

'Tis thus we ought to regard the Discoveries made by the Instruments, to which our Faculties and Improvements have given Origin: 'tis to the same Power who created the Objects of our new Admiration, that we are ultimately to refer the Means of our discovering them: let not any Enthusiast therefore accuse us of prying deeper into the Wonders of Nature than was intended for us. There is nothing we discover by these Assistances that is not a Source of Praise; nor is it simply innocent, but meritorious, to devise the Means of more and more Information in regard to God's Works. Had the Knowledge of these minute Orders of the Creation been necessary to us, or essential to our Well-being, he wou'd have form'd the Means of rendering them more universally palpable; but many Things are useful, which are not immediately necessary; and in these we have generally the Means of Information lodg'd in us, to be produc'd in their due Form, under the Exertion of our own Faculties, instead of an absolute and palpable Exposition of them before our Senses.

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The Part of the Town in which I live has the Advantage of being nearer the open Air than many; and to a Person fond of Exercise, and sometimes in Danger of Sickness from too continued an Application to Studies of the more intricate and abstruse Kind, this was an Advantage by no Means to be neglected. We naturally associate with Persons of the same Turn of Mind with ourselves; and as this Quarter of our general Scene of Business and Bustle, is not barren of Persons of a philosophick and studious Turn, it became as easy as agreeable to form Parties for little Excursions. The Proprietor of these Fields had some few Years since made a gravel Road for his own private Use across them, and it was a Surprize to some of the Party, who frequently enjoy'd these little Airings, to see a considerable Spot of the new-made Terrace, not many Months after it was laid, cover'd with a green Scurff, while the rest was clean. It was a damper and lower Part than the rest which had thus lost the Cleanness of its Appearance; and as it lay out of the Reach of a Gardener, the Matter, whatever it was, had an Opportunity of expanding itself undisturbedly.

The first Observation we had made was on a little Tuft of it, not more than three or four Inches in Diameter. This had stood under the Shelter of some high Grass on one Side of the Walk, and as our Visits to the Spot

were repeated almost every Day, it surpriz'd us to see how swiftly it expanded itself every Way, except where the Walk terminated at the grassy Side. It was not a Week before it had cover'd a Plat of two Foot square; in another half the Breadth of the Walk was spread with it, and in a Month it was a fine soft and silky Carpet, covering the whole Breadth of the gravell'd Space, and a Length equal to four Times that Diameter.

It would not be easy to conceive a Substance less likely to attract the Eye of a common Observer than was this. I have selected it as one of the most apparently despicable and inconsiderable Objects that could possibly occur; by way of shewing that even the most despicable to Appearance are not without Beauties worthy that Application which alone can discover them. The Generality of Mankind would have judg'd this Production unworthy even to be trampled under their Feet, the Gardener would have swept it off, and whoever had seen it would have call'd it by no better a Name than that of Filth, Foulness, Nothing. It was evident that it was Something; and, to the Perceptions of the Naturalist, it was as evident that it must have some regular Origin: Equivocal Generation is abundantly exploded: The Productions of natural Bodies are understood; and an Enquiry into the most minute of them is not without its Advantages.

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There are but three general Classes of natural Bodies, the Mineral, the Vegetable, and the Animal; to one of these therefore this new risen Something must belong, of mineral Origin it could not be, since all the Bodies of that Kingdom remain at least on the Surface of the Earth, such as they always were, and do not grow in this Manner in Places where before there were none of them. The Want of Motion, and the uninjur'd bearing the Violences of treading on it, separated it from the Animal Kingdom as readily; it remain'd therefore that it must be a Vegetable. To this none of its apparent Qualities afforded any Contradiction; and there was more than the negative Proof as to the two other Series for the determining it of this.

Vegetables have all of them certain incommunicable and unalterable Properties, the which they all enjoy as such; among the Number of these are, 1. Their being produc'd from the Seeds of Bodies in all Respects like themselves; and, 2. Their being determinate and limited in their Form. It appear'd then from the mere Principles of the Science, that what we saw in Form of this expanded Carpet was not one separate Plant, but a Congeries of several; and that these had not ow'd their Origin to any Chance, or unintelligible Power, but had grown there from the Seeds of other Plants of the same Kind, wafted thither by Wind, fallen from their parent

Tops among the Gravel at the Time of digging it, or by some other Conveyance brought to that Spot. Why of a whole Walk, of more than a Mile Extent, only one particular Spot should be cover'd with these Plants, appear'd on the same Principles easy to be accounted for. This single Spot was the only one shelter'd by the Accident of a neighbouring Rising of the Ground, and by the Height of the Grass from the Sun Beams, which fell with Violence on every other Part of the Expanse.

I have several Times had Occasion in the Course of these Essays to observe, that Nature allots an amazing Quantity of Eggs in Animals, and of Seeds in Vegetables, to continue the Species. Were these all to take Place, the whole Earth must be over-run with each single Kind, but the greater Part of them are devoted to Destruction; and 'tis therefore that the immense Number are created, that enough may succeed, though Millions perish. From whatever Source this Spot of the Gravel Walk was furnished with the Seeds of the Plant, there is no doubt but the same Wind wafted Millions of others from the same Source, and drop'd them at Random on the other Parts of the Walk, and even on the circumjacent Area of the Fields as plentifully as here. While Multitudes were choak'd by the Grass, or scorch'd to nothing at their first shooting by the Heat of the full Sun: this little Quantity that had fallen upon a sufficiently shaded

shaded and bare Spot, grew and propagated their Species.

Such were the Reasonings on this seemingly trivial Subject, as we one Evening surrounded it on the Spot: I rais'd a Quantity of it from the Surface of the Ground, to which it here and there adher'd by slender and scarce perceptible Roots, and brought it home. On spreading it over a Piece of Paper, we found it to be an elegant Piece of Network of Nature's Weaving. Its Fibres were extremely delicate, and they were interwoven with one another in an inexplicably intricate Manner: They form'd in the whole a loose Web of an elegant and bright green, and of a fine velvet-like Gloss. We were oblig'd to turn up the under Part of it, to examine its Vegetation; and then found that the Roots, minute as they were, did not proceed indiscriminately from every Part of every Fibre, but were produc'd in Clusters at separate Distances. It was easy to infer from this, that each Cluster of these was properly the composite Root of a separate Vegetation; and the whole Mass, which lay before us, compos'd of a Number of such single Plants: but it was impossible to disentangle them, to know the Form of any.

We fill'd a small Vessel with the finest Gravel, we press'd its Surface close down, and after rendering it much more even than it was possible for that of a common Walk to be, we fix'd down by little Weights the whole Crust  
of

of the green Matter, we had pick'd up on the Surface of the Gravel, at one Side of the Pot; and setting it in a shady Corner of my own little Garden, left it to its Fate. I made no doubt but that among the Multiplicity of Plants which form'd this Crust, there must be many with ripe Seeds on them; and as I had given them a better Soil than Accident could well have afforded, and set them in all the Advantages of a proper Exposure, I made no doubt that some of those Seeds would make their Way properly from the Confines of their Cells wherever or of whatever Kind they were, for all this was yet a Mystery, and falling on this proper Soil would vegetate; and by shooting distinctly and separately, give me an Opportunity of examining the Form of the Plant singly, which it was impossible to know any thing of as to its Figure, in the confus'd Clusters in which it had hitherto offer'd itself to the View.

I was not deceiv'd in my Expectation. Seeds were disclos'd, tho' too minute for any Observation that cou'd be made under such Circumstances, and young Plants were produced from them. The Quickness of the Vegetation in these minute and short liv'd Plants is surprizing. It was not thirty Hours from the Time of setting the Crust, before a Number of small Specks were seen upon the Surface of the before named Gravel; on examining these by the Help of a small Magnifyer, they appear'd to be so many  
young

young Vegetations, all of a round Form, and uneven Surface, and all in a vigorous State, and of a very elegant Colour, much brighter, and their whole Surface much more glossy, than that of the Parent Plant.

From this Time I watched this young Offspring with great Attention to their full Period; they encreas'd in Diameter during the first Day, and a Part of the second: at this Time they were of the Breadth of a Sixpence, still tolerably round in the Contour, but the Edges indeterminate. They seem'd to be now at their Maturity, and I took up several of them for Observation. I was not wrong in the Guess, those which remain'd soon convinc'd me of it, and shew'd the Method of these Plants from so many separate round Spots, forming a single irregular Expanse. On the Day succeeding that of my taking up the first of these for Examination, more little Spots of green appear'd every where between those which remain'd; these were the Produce of Seeds ripen'd in those very Plants, and these growing to their Maturity in as short a Space as the first, sprinkled their Seeds, which grew in the same Manner; so that by the Time of those of a third Generation coming to their Maturity, all which happen'd in about a Week, the Plants of the several Seminations were so close, that they intermingled their Branches with one another, confounding and loosing their Forms in one general Mass. Such was the Progress  
now

now trac'd in the Plant of its forming from such small and distinct Beginnings that silky Carpet, which at the Time of our first observing it had overspread a Part of the Walk, and which in a little more cover'd so large an Extent of it. Before the whole of my little Parcel was connected into one shapeless Mass, I had Opportunities of taking up several distinct and perfect Plants after the first Parcel, and by the whole found very perfectly the Form and Structure, as well as the Fructification of this singular, tho' so long neglected Vegetation.

As the Soil produc'd a Succession of Plants of all Growths and Sizes, I was soon led back from the Objects of my first Observation, which were the full grown ones, to the earlier Rudiments of them, in order to trace the whole from its Origin to its Period. I have observed, that the first Appearance of this Plant is in form of a little round Speck of green on the Surface of the Gravel; on raising one of these, whose Diameter was not equal to that of the Head of a small Pin, and bringing it before the Microscope, it appear'd a regular Plant. The Centre of it on the under Side afforded a great Tuft of Fibres of a whitish Colour, and extream Minuteness; these were its Roots: they arose from one Point or Head, and diffus'd themselves every way circularly. From these rose the Rudiments of the Plant. This view'd on its upper Side appear'd a Spot of a perfectly circular Figure,



gure, and very elegant Structure. It was form'd of an infinite Number of strait and regular Fibres, all similar, all of an equal Thickness, running strait like so many Lines drawn by the most accurate Hand from the Center of a Circle to its Circumference. These were not a single Series, but lay one over another to a great Depth; there seem'd at least ten or twelve Series of them. Their Colour was the brightest and liveliest green imaginable, with scarce the least Tincture of any other Tinge; but what they had, was rather of the yellow than the blue Cast.

The exact Regularity of these in Length, and consequently the determinate and even Edge of the Circle form'd by them, seem'd such as cou'd have been only made by their having been cut off at the Circumference; and what added yet more to this Appearance was, that they were of the same Thickness at the Extremities as at the Base; and as they lay over one another in such Manner as to form a Cake of some Thickness, their truncated Ends had an odd Figure, when the Verge of the Circle was seen in a side Light.

On applying more powerful Magnifiers, it was seen that however distinct and determinate these Fibres had appear'd, however perfectly separate Bodies they indeed were from one another, yet their Surfaces were strangely indeterminate: Each Fibre, when thus examin'd, did not appear as is usual in those of the other larger as well as smaller Plants, a distinct simple Body  
of

of a rounded or flatted Form, and continuous and even Surface, but each was seen to be compos'd of a Multitude of other still vastly more minute Fibres, and these not cover'd by any external Membrane, but loose and laid together in no very compact Manner. The whole Surface of each Fibre thus examin'd was perfectly irregular: we wonder'd that the several Individuals, which compos'd the Tuft or Plant, did not blend together.

This Period of the Vegetation might have appear'd the whole of the perfect Plant to a modern Naturalist: but 'tis not by a single Observation of one Specimen, in one single State, that we are to expect to come at the Knowledge of Natural Objects. The farther Vegetation of this Plant gave it a new Form; and I am apt to believe that this is the Case in many of the other Mosses not yet trac'd, and that the Number of Species has been multiply'd very unfairly by the Error of those Authors, who, understanding them to be imperfect Plants, have contented themselves with their Form, without ever enquiring about their Fructification; and consequently have taken every distinct Appearance of a Plant for a separate Species, and describ'd the first Shoot of this Kind under one Name, and the succeeding and more perfect Plant under another.

On tracing the Growth of this singular Vegetable farther, and taking it up at several more advanc'd Periods, I found that the Circle soon  
encreas'd

encreas'd in Diameter; and as it encreas'd, lost its regular and even Edge: this a Magnifyer of very small Power could distinguish, as the Plant was in its Place of Growth; but on laying it before the double Microscope, the whole appear'd in a much clearer Light. The Circle of simple Fibres first produc'd from the Seed of the Parent Plant, and which might at first Sight have pass'd for the perfect Plant produced from them, was now found to be no more than a Kind of Bed, or soft Matter, furnish'd by Nature to receive and support the tender Branches of the more perfect Part of the Vegetation: from the Center of this Tuft there soon arose four or five little Pencils as it were, of the most elegant and fine Hairs, of the same Colour with the Tuft itself, and more diffus'd at the End. These stand erect, and form a pretty Cluster: they soon grow to a Height equal to that of the Semi-diameter of the Tuft, and by that Time the Tops become too heavy for the feeble Branch which supports them, and they at once fall flat on the Tuft, dispersing themselves every way from the Centre, as the original and more simple Fibres before had done. The whole Tuft is now cover'd with them, and the Plant assumes quite a new Form, and might be easily mistaken for a distinct Species. Instead of a flat circular Tuft, it is now a thick and more elevated Cluster, and in the Place of the simple and equable Filaments that before compos'd it, it is now form'd of Clusters,

Clusters, or Pencils of Hairs as it were, all compact and close toward the Centre, and consequently slender there at their Base, and from this gradually unfolding and separating, and in Consequence encreasing the Diameter of the whole to the very Verge, where they terminate each in a loose Bundle of fine Hairs, or Fibrils of an unequal Length. The whole Original Tuft of the first Vegetation is now entirely cover'd by these, and appears indeed no more; and each of these Clusters of Fibrils forms a Body of the Figure of an inverted Cone, the Point plac'd at the Centre, and the Base at the Verge of the Tuft.

From this Time the Plant grows faster than before, so that this new Form it retains but a very little while. These conic Clusters of Fibres divaricate at their Extremities each into two Parts, and every Ramification after running to a little Length single is again divided, or sends off its Branches alternately, on one or the other Side. The Plant was by this Means soon enlarged to a Diameter equal to many times that of the original round Tuft; and tho' this continued in Circumscription round, or nearly so, the Verge of the Circle was by no Means fill'd up or close, but as the Branches the more they extended in Length, the more they separated from one another; tho' the intermediate Space were in some Degree fill'd up by the side Ramifications, yet the Points of the extreme ones were distant, and there were form'd Indentings or Openings  
between

between them, which were but in part fill'd up by the lateral Shoots.

The whole Plant, in its most perfect State, extended to a Diameter equal to that of a Six-pence, and form'd in some Measure a Representation of a Star with five and twenty Points or Rays, for so many were the principal Shoots from the Centre of what had originally been the Tuft. The Fibres of that first Production from the Root, now blended themselves in such a Manner with those of the Bottom of the Branches, that they became indistinguishable from them, and the whole form'd one complex Mass, from the Verge of which the Branches now seem'd to shoot not from the Centre, as they really did. Each of these Branches gave Origin to many subordinate Ramifications, and all these, as well as the main Trunk, were ornamented on each side with Pencils of Fibres, perfectly resembling the first Shoots from the Centre of the Mass; or, in other Words, from the Head of the Root. Each of these was of the Figure of truncated Cone, and each terminated in a Cluster of loose Hairs.

It is not easy to conceive any thing so elegant, as was the Appearance of the perfect Plant in this State, fair and clean, as the Care taken of the Place in which it grew had preserv'd it, and enlarg'd a little by a single Magnifyer. The whole Plant was of the same Form and Structure of Parts, and that perfectly unlike every other known vegetable Substance: the Stems or Trunks of the main Branches were in their most solid

Part toward the Base, only a little more compact than in the rest ; they were no where truly solid, or of an uniform or continuous Substance, but made up of Multitudes of green silky Filaments laid irregularly together, and shewing such Openings between them, that it appear'd very surprizing that they could at all keep their Form : the Ramifications were yet of a looser Structure than these, and so on to the extreme Tips, where the Fibrils were quite expanded and discompos'd, and perfectly resembled the Hairs of a fine Brush. It cannot be wonderful, that the Entangling together of the Multitude of these Plants, should form a wholly inexplicable Compages ; their very Ramifications are of such a Nature, that were they solid and continuous as in other Plants, they must yet on meeting be strangely interlac'd and entangled with one another ; but this is not all, for as we see it between the Branches and the original Fibres of the Tufts in the same Plant, so it is between the several Branches of the different Plants ; for on meeting they not only mutually entangle with one another, but their Texture being open, loose, and form'd of fine Fibres, they break and disunite, and in Consequence blend with one another, till the Result of the whole is a common Mass of fibrous and spongy Matter, in which the Form of the Plant is not at all distinguishable.

What the real and genuine Appearance of the Plant was, having been thus trac'd from out the Confusion in which these blended Quantities had

natu-

naturally involv'd it; there yet remain'd to discover whence came those Seeds, from the shedding of which the new Plants arose, and which were evidently not dropt under the Plants which had produc'd them, but thrown to a Distance from them, as the young and distinct Vegetations were always at a considerable Remove from the main Crust or complex Number, till the intermediate fresh Productions join'd them.

On viewing the several Parts of the Ramifications of a full grown Plant, before the full Power of the double Microscope, I discover'd, that though the Branches themselves consisted of mere Fibres, without any covering Membrane, there was the Appearance of some kind of Film or Skin in some of the Divarications. On tracing these little Appearances farther, I found they did not, as I had at first suppos'd, surround any Cluster of Fibres, keeping them together, but were simple Cases placed between the Bases of these, and serving to no visible Purpose. This gave me a Suspicion that they were the Receptacles of the Fructifications. They were very numerous, though extremely minute; their Form was that of an inverted Cone; they were form'd each of a very thin Membrane, of a pale yellowish green Colour, and their Cavities seem'd empty; their Rim was surrounded with a Kind of Cord, and the Cavity seem'd to penetrate quite to the Bottom of the Figure.

It was not without great Difficulty that I found the Way to tear and burst to Pieces se-

veral of these minute Cafes; but when that was done, there appear'd in the Bottom of each three round Bodies of a brown Colour, and glossy Surface; there were never more nor ever less than this Number, and the Bodies themselves had all the Appearance in the World of Seeds, but that they were in Proportion to the Plant much too large.

On the simple Filaments which form'd the Ramifications that stood immediately over these, there was thinly scatter'd a kind of Powder, which a less Power of magnifying had not discover'd to me; this was of a pale Flesh Colour, and compos'd of regular oval Bodies; and by its Arrangement on the Stalks, had greatly the Appearance of the Antheræ of other of the minuter Plants. I succeeded in dislodging many of these Globules on a fine Piece of Talc, and many of them were burst in the Operation. From all these there were forc'd out a fine Powder, which was evidently the Farina Fecundans of the Plant, and consequently these were indisputably the Anthenæ, the Globules of which this Powder was compos'd, when examin'd with the highest Power of Magnifiers, were found to be, as in the Farina of the larger Plants, all similar in their Figure and Magnitude: they are round, and not smooth, but cover'd all over with fine sharp Points. When view'd under the double Microscope, these Points discover themselves only round the Edges, and the Convexity or the Globule being undistinguishable because of its Opacity,



city, the Appearance is that of a Wheel, or some such flat Body, of a circular Form, and with a dentated Edge; but when examin'd before the largest single Magnifyer, in the Apparatus for viewing opaque Objects, the Convexity is seen, and the whole Surface is found to be cover'd with these Spines, which in the other View form the Denticulations at the Edges only. The Farina of many of the larger Plants is compos'd of circular Bodies dentated in this Manner at the Edges, as seen by that complex Apparatus which is the Microscope usually employ'd in examining them, and in all Probability many at least of these, if brought to the same fair Examination, will be found to be echinated Spheres of the same Kind.

It was easy to conceive how the Globules of this Farina should make their Way into the hollow Trunk which contain'd the Rudiments of the Fruit of the Plant, whither the Antheræ burst on their Pedicles, or fell off and became entangled among the Fibrils in such a Situation, as if not receiv'd whole into the Cavity, at least in reach of discharging so subtile a Powder, which was to burst from them into it. There remain'd therefore no doubt of this little Plant being like the greater Part of the more minute, or as they are vulgarly call'd the Imperfect Ones, of the Number of those which have the Male and the Female Organs of Fructification plac'd in several Parts of the Plant. We had sufficiently examin'd the Male Parts, and it was Time to

return to the Female ones, which we had dislodg'd from these Receptacles.

The Apparatus which had served to examine Bodies so extremely minute as the Globules of this Farina, could not be wanting in Power to shew very distinctly every thing that concern'd these comparatively larger Bodies. The double Microscope, as they were opaque, shew'd little more than their general Form, which was a depress'd spheroidal one: but on bringing them before the single Magnifyer, we found each to be compos'd of two Halves, join'd in the middle by a thick and prominent Ring; and the whole Surface pierc'd full of minute Holes. On Comparison of these with the Globules of Farina minute as they were, they appear'd greatly disproportion'd to them; and from this, and many Instances of a like Kind, I am confirm'd in the Opinion, that tho' the Globules of Farina are the impregnating Matter, or rather contain that Matter; they are not always receiv'd whole into the Receptacles of the Seeds, but burst on their Surface, and discharge that yet infinitely more subtile Matter which they contain upon the Fruit, whose Apertures seem calculated only to receive so fine a Substance.

The Structure of these Bodies confirm'd the Opinion first occasion'd by their Size, that they were not Seeds, but Receptacles of Seeds. Experiment afterwards evinc'd this in a very happy Manner, and shew'd not only the Manner in which these Plants are often produced at great

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stances from their Parent Sources, but explain'd in some Degree the Production of a Number of other of the less perfect Plants as they are call'd, particularly of the Mushroom and Moss Kinds, and their Appearance in Places where none had before been, and where but for such an Explication as this little Object offer'd, it is very hard to conceive how the Rudiments of them came.

While we were examining a small Slip of white Paper, on which by means of wetting it, and pressing it down upon the Parts of the Plant where these dislodg'd Bodies lay, we had several of them very luckily plac'd for Observation, the whole became confus'd, and a Kind of Dust spread itself before the Glass, and for some Moments impeded the Observation: when this was over, we constantly found one of the Bodies missing, and the Surface of the Paper, where it had been before vacant, dotted over with some new Matter, tho' very minute, yet sufficiently distinguishable. There is great Difficulty in managing these extremely minute Bodies, but we at length found a Way to confine the Fruits, which we afterwards examin'd in such a Manner, that nothing should be lost in Consequence of their flying to Pieces: it was in Effect of this Caution that we afterwards saw the whole Process: the Fruit, when it has been impregnated by the Farina, and is fully mature, bursts at once into two Parts, the Ring which surrounds it separating in its Middle: on the Instant in which the two Hemispheres are

separated, they by a sudden Spring become inverted inside out; and the Violence of the Motion, by which this is effected, throws out the Seeds with great Force. Each of these Bodies, while in the globular State, is full of the Seeds of the Plant, and all this Quantity is discharg'd at once into the Air on the Instant of the Inversion of the Halves of the Capsule. I had observed not without some Degree of Wonder, that the young Plants produced from the Seeds of the general Mass were not found close to its Side, but at some Distance; but in this, as in many other of our Acts of Admiration in these little understood Regions of Nature, the Wonder is misplac'd; for when the Form and Structure of the Seeds from which those young Plants are produced are known, the Miracle appears, that they are so near. Nature in Care for the Propagation of many of the larger Plants, has form'd their Seeds for flying before the Wind to a considerable Distance before they fall, by annexing a kind of Plumage to them: this is the Case in the Thistles, and many other of the wild as well as Garden Plants; but this Structure which we have been us'd to admire in these larger Bodies, is nothing when we compare it with the Form of those of this minuter Kind.

Upon the Bursting of a Capsule of this Moss, all the Seeds rise into the Air, and float in it, as if too light ever to fall: their Minuteness is not the sole Cause of this; for when examin'd  
singly,

singly, they are found wing'd with Down in a very different Manner from those of the larger Plants. A single Seed of this Plant, examin'd before the double Microscope, appears an extremely minute Speck of dark colour'd Matter, plac'd in the Centre of a comparatively large Sphere of the finest Down. It is round in its Form, and from all Parts of its Surface there arise Plumes of this fine Matter, extending themselves like so many Rays every way, and buoying it up. It is not a Wonder that Seeds thus minute should float in the Air, in the Manner of those Motes which we discover in a Sunbeam let into a dark Room; and that they should be carried to ever so great Distances, or suspended for ever so long a Time in it. The Wonder is rather, what makes them subside at all. This Provision, however, Nature has made for the Production of the Plant, that wherever they do fall, there they remain. The Ends of all the Plumages are of a bearded Structure, so that wherever they touch the Ground they lay hold of it; and if the Air be still, they remain in their Place till the Dews wash them away, and leave the Seed loose upon the Ground to vegetate.

The View of a Ray of Light let into a darkned Room through a little Crevice, shews us that, though we do not discover it under the common Circumstances, every Part of the Air is full of dancing Atoms; these Seeds may,  
from

from their Lightness and extreme Minuteness, very well be of the Number of those floating Bodies, tho' not visible to us: they are produc'd in almost infinite Numbers by only a single Plant; and as they are thus carry'd about, and are occasionally dropping to the Ground, tho' Millions of them fail by falling on improper Places, some will succeed; and these will be enough in Number to furnish the Air with Seeds for future, and produce those perhaps very distant Progenies.

We wonder to see Mosses appear on Walls, and Fungusses of particular Kinds on decay'd Timber in our Houses, as well as out of them. The Seeds of those Species of Moss and Mushrooms which have been discover'd are extremely minute; those of these particular Kinds, which surprize us thus with their extraordinary Appearance, have not yet been seen; they may be, so far as we know, such as those of this Moss, and if they be, the Wonder of the Appearance of the Plants from them in any Place where there is a proper Soil, if it may be so call'd, and Exposure, ceases.

ESSAY XIII.

*On the Form of a fresh-water Insect, and its Manner of Feeding.*

**T**HE several Ranks of living Creatures seem in a continual and even natural State of Depredation one upon another. We see it in the larger more conspicuously; but it is most abundantly shewn in the more minute, when we have the Curiosity and the Opportunities for examining them. The Wolf feeds on the Sheep, the Lyon on the Wolf; the Wren feeds on the Worm, and is itself eaten by the Hawk: and so on through the whole Race of the carnivorous Animals, whether they be of the quadrupede or winged Tribes. But this is little in Comparison to what the least Drop of standing Water shews to the inquisitive Examiner, in Myriads of different Creatures roying in it as a Sea, and feeding in their several Degrees on one another.

A little accidental Hollow in one of the broad Stones, with which the Area of the hinder Part of my House is pav'd, detain'd, after a hasty Shower, about four or five Spoonfuls of Water. I had the Curiosity to examine whether in this Fluid, as immediately falling from the Clouds there were any living Creatures; and the Experiment confirm'd the Assertions of those who have affirm'd that there are not. I left it

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undisturb'd about four Days: in this Time a great Part of it was evaporated; though the shaded and still Place had prevented it from all going, as it would have done if expos'd to the free Air and Sun. The Remainder of it was no longer clear and pellucid as it had been at first, it was cover'd with a Skin or Film, and its whole under Part foul, with a Variety of Mixtures. I took up a small Quantity of it in one of those concave Glasses, which are a Part of the Apparatus of the double Microscope, and applying one of the smaller Magnifiers, distinguish'd in an Instant several Animalculæ, not of the smallest Kind, swimming about very nimbly in it. On encreasing by degrees the Power of the Apparatus, by changing the Glasses from those of less to such as had more and more additional Power, a second discover'd to me another Race of smaller Creatures, not distinguishable to the first; a third shew'd two more distinct Series, which were invisible under even the encreas'd Power of the second Apparatus; and the greatest Power of the Instrument, while it gave but a very indistinct View of the larger Series, discover'd a Race smaller than all the rest, and more lively than any.

It is thus that the Powers of the Instrument ought always to be varied, and adapted to the particular Object of the Enquiry; nor are we to pay much Regard to the inexperienced Person, who, ignorant of this, disputes the Existence of Things seen by others, because his own  
Talents



Talents are not sufficient to lead him into the Road to the Observation. It is not only a different Power in the Apparatus, that will hide or discover the same Object in the same Fluid; even so apparently trivial a Circumstance as a different Proportion of Light under the same Apparatus will perfectly shew, or totally conceal an Object that exists in the Substance to be examin'd. There are many of the most singular Subjects of our Observation which are so delicate in their Frame, that they are pervaded totally, and therefore lost to View in a full Light, while a more partial one shews them in Existence and in Motion; so that while a Man of Probity is censur'd, because the unequal Examiner does not see what he points out to him; perhaps if he were present, the whole would be shewn by a slight Turn of the Speculum.

I observ'd in this Instance, as in all others, that Nature regards her Proportion in Numbers on the Plan of the Size of the Individual. The largest Insects are ever the fewest; and the others, as they decrease in Size, offer more and more in Numbers, till of the last, or lowest to which our Powers of Magnifying will lead us, there are Myriads to one of the larger. The Quantity of three Drops of the Water from this little Puddle, shew'd me in this Manner, under different Powers of viewing it, no less than five Orders of Beings all full of Life, all seeming to enjoy that Life in the happiest Manner, and all perishing, or in Danger to perish every  
Instant

Instant by one another, yet no more conscious of this than of the inevitable Destruction of all together from the Evaporation of the Water.

I first adapted the Magnifiers of largest Power to the Enquiry into the Nature and Œconomy of this numerous Host. They shewed me very distinctly the Myriads of the most minute Species; and, tho' less distinctly, gave me a Sight of those of two or three of the larger, as they pass'd occasionally by; tho' the Area they took in was so small, as seldom to keep any, except those of the second Order, in Sight a Moment together. The Life, Spirit, and Vivacity of the least of these Creatures was amazing; they were in continual Motion, and that in all Directions, with equal Ease and Rapidity. They were in Shape exactly round, and of an Appearance so delicate and tender, that it is not a Wonder they have escap'd the Sight of many, who have thought they examin'd these Fluids carefully. In a full Light they totally disappear, their thin and perfectly transparent Forms blending as it were with the Water in which they swim; in a more advantageous Degree of it, all that is discover'd is often no more than the Appearance of a thin and extremely fine Line, marking the Circumference of a Circle, which would never be suppos'd to have any Title to be thought animated, but that it is eternally changing Place, and that with a very rapid Motion. When the utmost Advantage of Degree of Light is given, which is when the  
Speculum

Speculum is so turn'd asslant, that but a very little Light is reflected upon the Plate on which it lies. We discover this not to be a mere empty Circumference. What appear'd only the Outline of a flat Figure, is now seen to be a globular Animal. We distinguish somewhat of the Top, and the Descent of the Side, and find that it is a Creature of a perfectly spherical Form and pellucid Structure, seeming compos'd of nothing more than a very thin and delicate Membrane distended with Water, but having in its Centre a few oblong or roundish Spots. These, when closely examin'd, appear to be the Intestines; they usually occupy about a sixth Part of the Cavity of the Body, and seem of a somewhat firmer and more dense Structure than the rest. On the under Part of the Body, for the same Surface of it is while the Creature lives always carry'd uppermost, is situated the Mouth; this is only to be distinguish'd by taking an Opportunity when one of them is by any Accident turned over, which often happens; it is an oblong Slit, large in Proportion to the Body of the Creature, and communicates with the Intestines: they may be trac'd indeed in a Line, taking their Origin from this Aperture, and continuing their Course in a strait Direction to the midst of the Body, where they extend and divaricate themselves into several Portions, and at length form that Congeries which is so distinguishable thro' the Skin, and from every Part of the Animal.

These

These are the minutest Portions of Matter which our best Apparatus of Magnifiers are able to discover to us ; yet that there must be smaller is evident, since these must have Food, and Nature which has given them Mouths and Intestines to take in and digest that Food, would not have them destitute of it. How minute the Portions of Matter, whether they be Animals, or of whatever other Kind on which these Devourers feed, must of Necessity be, is evident from this, that those Glassess which can shew the Mouths of these, and can even discover the Forms of those Mouths, and make them of some considerable Extent, do not give any Sight of them.

It is distinguishable, that the whole Aperture of the Mouth in this Species is serrated in the Manner of the Sides of the Beak of a Duck, the Serratures in all Probability serving the Creature as Teeth. For the rest, the whole Animal is a floating pellucid Globule, which can so well be compared to nothing in the World as to those Bladders blown by Children from Soap Suds. It appears as thin, as transparent, and as tender, only the Cavity is not quite vacant, because of the Intestines. This Species of Animalcula was by much the most numerous in the Fluid I had now to examine, they swam about in it indeed in Myriads, and seem'd to enjoy themselves with great Jollity, scuding from Part to Part with the utmost Agility, rolling and turning themselves over at Pleasure ; and when their Clusters  
were :

were so thick as to impede one another's Motions, throwing themselves over their Heads, creeping under the whole Range, forcing their Way through the midst, or wheeling round the whole Cluster with a surprizing Rapidity. It was not only that, the Microscope could discover nothing for them to eat, that would induce one, were the Supposition natural, to imagine they liv'd without it, they never stop'd to seize or swallow any thing. Motion seem'd their great, indeed their sole Delight, and that Motion was incessant, in all Forms and Directions backward and forward, to one Side and to the other, in Angles circularly, and in a thousand other Directions in the Space of a single Moment.

Though it was impossible to discover that these Creatures eat, it was equally impossible to miss the Observation that they were eaten. It had at first appear'd surprizing that Nature produc'd such amazing Multitudes of these to over run the whole Extent of the Matter, and crowd upon, incommode and starve one another; but it soon appear'd on the contrary, when we saw the Devastation that was made among them by the next Order in Size, and in fine by all the several Kinds of larger Animalcules that inhabited the same Fluid, that the Wonder was how any Number, ever so great, cou'd supply such Multitudes as these found necessary for their Support, how any Provision cou'd be

made for keeping up the Species amidst such universal Destruction.

These jovial Creatures I found were the common Prey of every thing larger than themselves, they were furnish'd with no Weapons of Defence, they had no Apprehension of the approaching Slaughter; and indeed they seem'd of no Use in the Ranks of Beings, but to pick up Food dispers'd in Atoms, too minute for the Attention of Creatures of superior Size, and by their own Digestion to prepare it for the Nourishment of the others. This might appear a very hard Lot; but the utter Insensibility of the Creature itself to it, takes off the whole Severity. There does not seem an Animal in the whole Creation that enjoys its Period, short as it is, with more Jollity than this; Life is one continued Dance and Sport, and at its Termination it sinks in a Moment into that Nothing out of which it knows not how it arose.

The second Order of Inhabitants of the Fluid under Examination, were distinguishable enough under the same Apparatus with that which had been us'd for these; but the Area it took in was so small, that a Combination of somewhat less Power was sufficient and more agreeable. Under these Glasses we had an Opportunity of seeing many of the Animalcules of the second Series at once; whereas it was before but by Accident that we got a Sight of one, and that usually but for a Moment, the Area taken in being such,  
that

that the Creature was on its first Motion out of it. We had now a fair Opportunity of contemplating the Forms of these, and found them surprizingly constructed, and of Figures and Properties before wholly unknown.

These Animalcules of the second Series were not of a spherical Figure, like those of the first, though of a circular Circumference. They are as pellucid as the others, and like them, under a too strong Light, either quite disappear, or shew only the Line that marks their Circumference. When examin'd under the proper Advantages, we found them to be so many regularly figur'd Lumps, or Masses of a gelatinous Matter, endu'd with Life and Motion, and employ'd continually in Search of Food.

The Figure of this Creature is that of a low Cone; with a very broad Base, and an obtuse Summit. The Body is, in Consequence of this Form, thickest in the middle, and gradually thinner to the Edges; and it is consequently also less transparent in the middle than elsewhere. Its Colour is a very pale pearly blue, and its whole Body is almost continually in a tremulous Motion. It seems a mere loose Jelly; and as the Membrane which encloses it is too delicate for the sharpest Sight, thus assisted, to distinguish, one wonders that the Mass is capable of keeping its Form. In the midst, thro' the Thickness of the most elevated Part, and the circumjacent Sides, are seen the Intestines; they are very simple, compos'd of a few Volutions, and of a

somewhat darker Colour than the rest. Toward the Sides, or Edges, the Body grows thin, and the Creature has a Power of moving it about in a vibratory Manner at its Pleasure. In order to get a more distinct View of this Species, we were oblig'd to get some of them in a more minute Portion of the Fluid between two very thin Flakes of Talc, on the turning of which under the Microscope, we became able to see the under Surface of the Body, which as the Creature never turn'd itself up in any of its Motions, it was impossible to do, only by looking down upon it as in Motion, in a larger Quantity of the Fluid.

On Examining the under Part in this Manner, we found that it was not plain or flat, as might have been imagin'd, but hollow'd up to the Centre, where was plac'd the Mouth. It was only by a narrow circular Rim, that it touched the Glass, or the Bottom of whatever else it crept upon; from this Part the Body rose higher and higher to the Centre, so as to form a Conic hollow, answerable to the Form of the upper Surface; and the Creature now therefore appear'd not that solid Mass of Jelly we had imagined, but of a much more singular Form.

The Mouth, which was plac'd in the Centre of this Hollow, was of a round Shape; and from its Centre there was produc'd an oblong Cylindrical, and sharp pointed Body, which was evidently a Proboscis or Trunk, like that of the  
many



many others of the Insect Kind which live by Suction ; this we perceiv'd was capable of being lengthned and shortned at the Creature's Pleasure, and even as it was protruded, we could see a circular opening all round its Base, and within the Verge of the Mouth, which did not appear at other Times.

The whole under Surface of the Body of this Animalcule was smooth and glossy as the upper, and its Substance had the same gelatinous Appearance ; we could also trace the Intestines in this View much better than in that from above, the Covering of Flesh on the upper Part being thicker than on this. We could here trace a Kind of Œsophagus, passing from the hinder Part of the Mouth to them ; and cou'd discover that after forming a Bag or Sack at the Bottom of this Passage, they ran out into a little Length with a few slight Volutions, and sent out on each Side several Appendages of the Nature of the Cæca, or blind Guts of Quadrupeds, and more particularly of the Fish Kind.

What was a very lucky Circumstance in our Favour was, that the Animalcule on which we made this Observation continu'd still living. We had observ'd from the Beginning something like a fring'd Edge to the Circumference of the Body : on directing the Eye that Way more determinately, we found there a Circumstance more worth our remarking than all that we had seen before. The whole Edge was indeed fringed, but this Fringe instead of consisting of

mere Fibrils, as we had imagined, we now found to be a Series of Arms or Legs, by which ever Name it may be most proper to call them, for they serv'd to the Purposes of both. The Number of these was amazing; it was scarce possible to attempt a Calculation, partly from their extreme Minuteness, and partly from their being continually in Motion. The nearest Approach I could make toward it was, by making something like an Enumeration of those which were plac'd on what I took to be one sixteenth of the Circumference; these could not be less than seventy, so that the Number of the whole must undoubtedly be considerably more than a Thousand.

These Legs are all of the same Length, and their Motion is simple, merely of the vibratory Kind, and that consisting of only the drawing them in, or expanding them out. When perfectly drawn in, they cover'd two thirds of the Surface of the Body, between the Verge and the Mouth; but as the Sides themselves had also a Power of bending inwards, the Creature by this Means cou'd throw them so much forwarder toward the Centre, and by that Assistance cou'd make them reach to the Verge of the Mouth, or without throwing them upwards to it, cou'd by directing them merely horizontally, make them meet one another at their Points, and form a Kind of open Floor, under the large Hollow of the lower Part of the Body.

On

On suffering the Creature to walk, by removing the Plates of Talc to a somewhat larger Distance, we cou'd discover, that though it us'd some of the Limbs, by whatever Name they are to be call'd, to this Purpose, it did not employ them all about it, for while it walk'd by means of about a sixth Part of them, as nearly as cou'd be guess'd, the rest were directed horizontally outward, and still form'd that Kind of Fringe which we had first, and at all Times seen about the Body.

When we had thus far inform'd ourselves of the Structure, and several Parts of the Creature, we return'd to our first Scene of Observation, the somewhat larger Quantity of Water in which several of this Species were swimming more at Liberty, and performing the several Offices of Life. The first Observation we made on this Occasion was, that heavy and unweildy as this Creature seem'd, it was not, as we had imagin'd, doom'd solely to creep upon the Bottom: the Limbs, which we had already seen acting in the double Capacity of Arms and Legs, now assum'd a third, and were employ'd occasionally also for swimming. The Creature, though it often crept upon the Surface, occasionally rais'd itself up into the mid Fluid, and by the Vibrations of a small Number of these Appendages supported itself there, while the rest were destin'd to other Employment. It was in all Positions we found that these Filaments were but partially employ'd in the Motions

of the Creature; the greater Number always remaining at Liberty for Offices of no less Importance.

This Animalcule we soon discover'd was the profess'd Destroyer of the other small Species we had before been looking at: its whole Business of Life seem'd indeed to be Eating; and the unguarded and undefended Nature of the other supply'd itself so freely, that it appear'd wonderful the Appetite cou'd continue. Had the Creature ever eaten the whole of the Animals it destroy'd, it would have been impossible to have found Capacity for the Quantity, but it only sucks the Juices, and these seem in very small Portion in each.

The Methods of Destruction used by this Beast of Prey were various, but equally destructive; sometimes it attack'd them on Foot, or as it walk'd along the Bottom; sometimes it drew them in as it stood motionless, and sometimes suck'd them up, as it diverted itself in Equilibrium. In which ever Posture it remain'd, the Business of Destruction went on in the same Degree; and what was more cruel, the Creature seem'd independantly of its Pleasure in Eating, to make a Diversion and Pastime of the taking them.

In Things of such extreme Minuteness as the Arms of this Creature, especially as they are also in continual Motion, it is impossible to discover their minutest Appendages; it appear'd however to Experiment, tho' we could not make it

an Object of Sight, that these Arms or Legs were furnish'd not only with a Kind of Claws, but with Hooks or some other Instruments calculated for the same Purpose, for wherever they touch'd the Prey it never escaped. I have observed, that whatever Use the Creature made of these Limbs, as to maintaining itself in its Position, or changing Place, there were still the far greater Part of them at Liberty for other Offices. These were always employ'd in seizing and conveying the Prey to the Mouth.

We first observ'd the Manner of its taking them, as it stood motionless on the Bottom; we could discover on this Occasion, that the Verge or Rim of the Body did not of itself touch the Glass, but was supported at some little Height from it, by about a sixth Part of the Legs, and the Water had a Passage under it. In this Situation, the rest of the Limbs were stretch'd out to their full Length in a horizontal Direction, and form'd the Fringe, mention'd before, all round the Verge of the Body; as the lesser Animalcules were continually in Motion, one or other of them singly, and often many of them together, came within the Compass of this Fringe: not one that did so ever escap'd. Whatever Filament of the Fringe, or in properer Terms which ever Arm of the Creature touch'd the unhappy Victim, fix'd its Hold on it, and in an Instant convey'd it under the Verge to the Mouth; we were amaz'd at the Creature's insatiable Appetite, on seeing  
the

the Numbers that were continually thus thrown into its Jaws; but it was not without considerable Difficulty that we discover'd the Method of its feeding on them. This we found to be very simple and instantaneous. The Moment the Victim was brought into Reach of the Instrument of Destruction, the Proboscis or Trunk beforemention'd, that was plung'd into the Body directly upon the Part where the Intestines lay. The Bubble burst upon the Instant the Fluid which had fill'd the general Cavity of the Membrane dissipated itself among the rest of the Water, from which it seem'd no Way different. The Juices of the Intestines were receiv'd into the Trunk, and that was drawn up into the Mouth to convey them to the Œsophagus, and was ready again for new Destruction. The whole was the Work of the minutest Portion of Time, of which we can have any Conception, and was repeated incessantly, new Food being continually brought in by some or other of the Legs, and the Creature finding it necessary every now and then to change Place, to get rid of the Quantity of Skins, and Spoils of the Prey which were accumulated under it.

When it was in a Humour to walk along the Bottom, still greater Numbers of the lesser Animalcules perish'd by its Appetite. They generally keep together in Clusters, and through their utter Insensibility of Danger were cover'd, as it mov'd about in vast Numbers  
by

by the Expanse of its Verge, and destroy'd as quick as it could repeat the darting down and drawing up again of the Trunk. Even this abundant Destruction did not however seem always sufficient for it; when it was hungry enough to want still larger Stores at once, it would raise its Body from the Bottom and directing itself in the Water, by a slow Motion toward some Part where they were most numerous, it wou'd expand all its Arms to their utmost Dimensions, and fall at once to the Bottom in this State, overwhelming Multitudes at a Time, and comprehending them all in the Manner of the Fish under a Casting Net, till it had destroy'd every Individual of them.

These several Methods of Preying seem'd to have their Share of Sport as well as Feeding; but there was one we afterwards observ'd, yet more destructive than them all, and which was evidently a Piece of Pastime of a very amusing Kind while it was practis'd. The Creature wou'd, in order to entertain itself in this Way, raise its whole Body to a small Distance from the Bottom, over some Place where the unhappy Objects of its Depredations were plentiful enough, tho' not so crowded as in those Parts where it threw itself over them, in the last mention'd Manner. It would here support itself by the gentle Vibration and Expansion of a few of its Limbs, as the Kite does when it sustains itself on the expanded Wings, without any Motion of them, and while thus suspended

pended by the few, all the rest would be constantly and incessantly employ'd in one and the same Motion, which was that of forcibly drawing themselves in under the Body, and then by a much gentler Stroke expanding themselves out again, to be clasp'd in the next Instant in the same Manner. This repeated Motion form'd a Draught of Water from all the adjacent Parts up to the Centre, at which the Points of the Arms met, that is up to the very Mouth of the Creature: with the Water were drawn up the light Bodies of these defenceless Animalcules, and the Creature, while it diverted itself with this Play of its Arms, darted its Trunk incessantly into the Bodies of those of them that came up with the Water.

If they came in but slowly, the Motion was incessant, and though many escap'd in the Confusion, yet the repeated Supply made up for the Deficiency; but if at any Time, as it wou'd occasionally happen, a whole Shoal came at once, all the Arms were incessantly drawn inward, and form'd that Kind of horizontal Floor already mention'd, which retain'd all the Creatures within the Cavity of the under Part of the Body, till they were one by one destroy'd; after this they fell at once, to let drop the Skins, and immediately after were thrown into their old Motions to bring in more.

If the Man who values himself on the Delight of Eating, would enter into the Comparison



rison with this pitiful Animalcule in his favourite Pleasure, what could he boast in Comparison with the Enjoyment of the Creature he would be so apt to despise. Here is an Appetite incessant, and incapable of Surfeit or Satiety, a Pleasure in the seizing the Prey, superior to that of the keenest Sportsman, and more swift; and yet what is this happy, this to such a Person, enviable Worm, but the Prey to another Species a little larger than itself, to whom it serves only as the Drudge, to pick up and concoct Morsels too inconsiderable for its immediate Regard.

Such were the Forms, Structure and Œconomy of two of the five Series of Beings which inhabited a few Drops only of some Rain Water, which had escaped by its Situation the common Fate of much that had fallen in the same Shower, of being evaporated. Had this fared no better, what a Multitude of Creatures wou'd have miss'd the Enjoyment of their Existence; had all the rest been retain'd under the same favourable Circumstances, what Myriads more would have had it. 'Tis in Contemplations like these, that the Mind soars to some faint Idea of the Universality of the Works of Nature, of the amazingly prolifick Power with which the Existence of the Non-Existence of Millions of Millions of Beings makes no Changes, which sees them call'd into Life by the Concomitancy of Accidents, or deny'd that Blessing by Circumstances as trivial, yet  
neither

neither the one nor the other making any Change in the amazing whole, in which one Accident is so well calculated to answer the Effects of another, that the World is still supply'd, and never overstock'd with any Species. To the Creator of an Universe of Orbs behind Orbs, of Suns beyond Suns, through all the Regions of unbounded Space, we who pride ourselves as Lords of this Creation, may be as inconsiderable as the minutest Worm, to which we see the least Accident can give or deny Existence; which ourselves can destroy, and in a Manner produce.

The immortal Part of us, is what we may indeed with Justice pride ourselves upon, as above the Reach of Accidents, beyond the Power of Chance, beyond any Power indeed less than that of the Creator of the World to call into Being, or to put out of it again; as to the rest, in the whole, it is as inconsiderable in the Comparison of the Importance of a whole Universe, as these minute Existences, however cheaply held, are to us; nor is there more Importance in the Ranks of Armies, and the Fate of Empires, Things which to us in our high Opinion of ourselves, appear Events of the highest Nature, than in the Destruction of a Legion of these Animals, which we tread to nothing at one Stamp of our Foot, or which a Sunbeam or a Breath of Wind parches up or scatters off, with the whole World of Water  
they

they inhabit, to be lost in that common Abyss the Atmosphere.

Superior in Consequence to the two Series of Beings we had hitherto examin'd, there were in the same Fluid three other Kinds. These we saw at one View, as we adapted a smaller Power of Magnifying, than that which had been necessary for what we had hitherto been about; but the next in Degree became the immediate Object of our Investigation. The small Area or Compass taken in by Glasses which magnify sufficiently to discover to us the Lineaments and Forms of the minutest Creatures, give us but a poor Opportunity of seeing the larger; we had during the Observation of the latter Animal, seen another of enormous Bulk in Comparison with it, enter the Space comprehended by the Glasses, but as soon leave it again. The Power we now used was sufficient to distinguish the Form of this, and at the same Time took in a Space of the Water enough for it to perform its several Motions, without being continually going out of our Reach.

We observed that this Species more exceeded the Second in Magnitude, than that had done the First; in Figure it was perfectly different from either. It was of an oblong Form, and considerably thick; it more resembled the Caterpillar Kind than any other of the larger Insects in its general Form, but it had nothing of the particular Characters of that Genus. We had an Opportunity of seeing several of these in  
Motion

Motion at once, but we singled out one which was larger and more vigorous than the rest, for the immediate Subject of our Examination. We found its Body all the Way of the same Thickness, and it mov'd with either End foremost with the same Ease and Swiftnes. This render'd it difficult to say, which was the Head, which the Tail; nor is there indeed any Creature in the World that more brings into one's Thought the fabled Amphibæna, or Serpent, pretended to have a Head at each Extremity of the Body.

The Body of this Animalcule is not rounded or cylindrick, but angulated, and that irregularly; the Ridges are four, but they are not placed so regularly as to make it a Square; and the continual Contortions of the Creature give these an Appearance of yet greater Irregularity. The whole Body appears to be soft and tender, it seems indeed little more than a Quantity of a pulpy Matter enclos'd in a very thin and delicate Membrane. It is not pellucid and colourless as the others, but its general Tinge is a faint yellow, and this is spotted with large Variations of a deep green. There are other Colours usually seen about it also, but these seem the Effect of the different Lights thrown out from the Speculum, the yellow and green are the only inherent ones; and the green Variations are more frequent towards the Middle than elsewhere.

The Motion of this Animal is performed without either Legs or Fins, so far as appears to the strictest

strictest Scrutiny; it is chiefly progressive, and in a strait Line, and is not very quick. The whole Body is flexible, and is continually thrown into a Number of Contortions and Convolutions; and it is owing to these that the Motions are performed. We observ'd it rolling its unweildy Form about for a considerable Time always in the upper Part of the Fluid, and seeming to intend nothing but to divert itself by its Motions, till at length it came to a Part of it where one of the Insects last mentioned was suspended in the midst, and was entertaining itself with the Destruction of the little ones from below. It was now that we discover'd at which End the Head of the Creature was plac'd. It approach'd the Destroyer without any seeming Emotion, and opening an enormous Mouth, at the Extremity which was then going forwards, seiz'd it by the Back, and in an Instant sunk down with it to the Bottom of the Fluid. The first Gripe of this terrible Mouth had taken out a Piece equal to a Hundred of the little Kind in Bigness, and at two or three Bites more the whole was swallow'd. The Creature fed regularly, it did not gnaw at the Prey, but wherever it laid hold took out a large Piece, and eat that before it return'd to the Body. When it was devour'd, we saw the Creature which had committed the Destruction, raise itself up by Degrees into the Fluid again, and roll about at its Ease in Search of new Prey. We had now the Curiosity to adapt a somewhat more

powerful Magnifyer, and to get one of this Species into a more convenient Apparatus between two thin Slips of Talc, for the examining the Structure of a Mouth capable of doing all this Mischief. We found in this more strict Examination no Trace of any Limbs, or other Appendages; the Body was annulated, as in the Caterpillar Kind, or divided into about fourteen distinct Joints by so many Rings, its Tail was obtuse, and as large as the Head; but at the Head we saw a Fissure, which was evidently enough the Mouth, though at this Time close shut; we waited its Opening, which happen'd as we had expected, when the Creature fell into the Agonies of Death. It was not a great while before it open'd and shut very quick, and after that more and more slowly; at length it gap'd to its utmost Dimensions many Times, and preserv'd itself in that Situation a great while, seeming to try even to open farther, as if to bursting.

The Fissure ran strait along the Middle of the Head, and when it open'd it was plain that both Jaws mov'd equally; we had in many of these Openings an Opportunity of seeing its Structure and Armature for Mischief; and it is scarce to be conceiv'd, that so inconsiderable an Animal should have been furnish'd with so terrible an Apparatus. We see in the Mouths of the Shark Kind, and several other of the more voracious Fishes, three, four, or more Rows of Teeth; each Jaw of this minute  
Creature

Creature was furnish'd in the same Manner; and as in the Shark the Teeth are moveable, we were after several Observations of Opinion, that those also of this Insect were so; it is hard to determine with Certainty of so minute Objects, and those in Motion too, but I think that at least the outer Row of Teeth in this Creature have a Power of depressing or elevating themselves at Pleasure.

'Tis not easy to say, how many Rows of these there are in this Creature; the two outer Series on each Jaw are long and slender, and those within shorter and thicker; nor is there any End of the Appearance of Teeth, or of something answering to their Purposes, in the Mouth; for the whole inner Cavity of it, both the upper and under Surface, are furnished with a rough and denticulated Skin: there is no Tongue, or at least if there be it is fix'd down to the Floor of the Mouth, and its Surface, as well as the whole Palate, are serrated both transversely and longitudinally, and the Points between the Serratures have an Appearance of short Teeth, and doubtless have their Uses.

What an Armature of Mouth is here for an Animal in its general Appearance so inconsiderable, and which any one, who did not see it feed, would suppose so perfectly below all Power of Mischief; yet idle and careless as it appears in its rolling about the Fluid, it is in continual Search of Prey, and nothing that it meets escapes

it, unless very considerably larger than itself. It is not only this larger of the two subordinate Series that it preys on in this unmerciful Manner, the others, as they generally are together in large Companies, it swallows by whole Shoals at a Time, wherever it comes opening its Mouth, and without Trouble closing it again upon Multitudes of those Minims of Existence, which perfectly free from all Fear swim between its Jaws as readily as any where else. One closing of the Mouth destroys Multitudes of them, and it is immediately open'd again for more; but this seems a very indolent Way of Eating, for the Creature is quite unmov'd at it, as if the Jaws open'd and clos'd in Play; nor do we see any Appearance of Attention in it to Feeding, unless it be when it has attack'd one of the more bulky and fleshy Creatures of the other Kind.

The Devastation committed by the Animal of the second Degree of Size, we see is thus amply returned by that of the third, tho' not in regard to the Numbers in general; yet, even in this Point, in Quantities proportioned to the Number of that Species in Comparison of the other: but the Destroyer of this third Kind does not escape its Fate. The Water is inhabited by a fourth, and even by a fifth, which prey not only on one another, but on all the three Kinds beside; and that with an almost insatiable Ravage.

The Animal of a fourth Degree of Size, reckoning from the most minute, the largest  
of



of all the Inhabitants of the Fluid except one, is of a Form quite different from that of any that has been hitherto describ'd, and tho' furnish'd with sufficient Means of Destruction, carries as little Terror in its Aspect as any Creature in the World. It is so much larger than the last describ'd, that a Magnifyer of less Power is sufficient to distinguish its Form, and all its Parts, and such a one is necessary for the taking in an Area sufficient for the performing its Motions within the Reach of the Apparatus. It is of an oblong Form, and obtuse at each End; but that which always goes forward in the Motions is the smaller. The Back is convex, but not very greatly so, and the Belly is flat. There is not at either End any Distinction of Form that could put a Person in Mind of the Difference of Head or Tail; nor is there any Appearance of Legs, Fins, Filaments of any Kind, or any other Apparatus at its Edges, by which it should perform its Motions. It moves very slowly and gravely, and seems to owe the Power of doing so to the Flexibility of its whole Body, particularly of its Sides, and its hinder Extremity, which seem very thin, and are continually in a more or less strong vibratory Motion. Its Progression is in general very even, regular and steady, only it will sometimes turn over Head in a very ready Manner, so as to throw the Belly upward for a Moment, and then recover its Position again; we observ'd that it principally did this, while it pass'd near some other Animal lesser than itself, sometimes as it

went by the largest of all the Inhabitants of this Fluid; and when it had made this Motion, it generally fell into a State of Rest and Inaction, as if to recover itself, and usually sunk to the Bottom.

The Colour of this Creature is the same with that of the second describ'd Kind, a pearly bluish, only that there is a Tinge of green running through it; and it is spotted all over on the Back with large Spots of an oval Figure, and of a purplish Colour; these are largest and most conspicuous of all, at the very Top of the Convexity, and grow gradually smaller and paler both Ways, till they are almost lost near the Sides. The Belly, when we occasionally saw it, was of a pale whitish Colour, and seem'd to have certain Series of Hairs on it; but these we had Opportunities of examining more accurately afterwards.

It was not long that we had been employ'd in looking upon this seemingly tender offenceless as well as defenceless Animalcule, when we found it, tho' we could not at first distinguish by what Means, a great Destroyer. We observ'd, that whenever in the Course of its Progression, for it seem'd never to put itself out of its Road for any thing, it came up with any of the Creatures last or last but one describ'd, those of the second or third Degree of Magnitude from the smallest, it constantly took the Animal down with it to the Bottom, and rose again after a few Moments without it: on a closer Examination, it appear'd  
that

that it destroy'd all on which it seiz'd in this Manner: nor was this its whole Devastation, if it it happen'd to be on a Level with or above the Object of its Hunger in the Fluid, this was its Method; if below it, it never took the Pains to rise to the Level, or to a higher Part of the Fluid, but turning over Head, it brought its Belly to bear against some Part of the Animal, and by that Means inflicted a Wound that destroy'd it; and then either adher'd to it there, or carry'd it down to feed on it. This was the Explication of that odd Circumstance we had at first seen without understanding it, of its turning over, and immediately after becoming at Rest. The Shark has its Jaws so form'd, that it cannot seize on any Thing without first turning on its Back; but this was not the Case with the Insect under Consideration: it with equal Ease fasten'd on its Prey from above, or from either Side, and the whole Matter of its turning up to give the Wound was, that it might when too idle to rise, or perhaps because rising in the Water might be troublesome to it with that Apparatus, wound from below as easily as from above.

When we had seen enough of the Destruction this Creature had dealt among two of the under Series, and sometimes upon the larger Kind, which seem'd form'd by Nature out of its Power, we were curious to know the Apparatus, by which the Mischief was perform'd. Whether it fed on the smallest of all the Species we could

not determine, since the Apparatus of a due Degree of Power for the Examining this Creature left those invisible, but from the very inconsiderable proportional Size, it is probable it does not. The Method of attacking and conquering all the rest was the same. The Instant that it seiz'd on the Prey it went to the Bottom with it, or else, which was most rare and only when the Creature was smaller, it remain'd suspended in the midst, and never left hold till it gave up the empty and useles Skin. If it seiz'd the Creature sideways, it seem'd to drag it down by its own Weight in the instant Fall to the Bottom; if it fell upon it from above, it press'd it down with the whole Force, and seem'd to clasp its thin and moveable Sides round it; and if it turn'd upon the Prey from below, it always instantly turn'd over again with it, and down they went any way together.

When we had thus sufficiently gratify'd our Curiosity as to its Manner of Feeding, it remain'd to see by what Apparatus it effected it, what Weapons Nature had allotted it, and in what Manner it employ'd them. To this Purpose we put a smaller Portion of the Water, in which there happen'd to be two of these Creatures, between two thin Slips of Isinglass, and fixing them in a Slider of the Microscope without pressing down the Rings in such a Manner, as to squeeze the Talcs quite together, we had an Opportunity of employing a somewhat larger magnifying Power, and of seeing sometimes the upper, sometimes

sometimes the under Surface of the Body, as we turn'd the Slider with the one or the other Side upwards.

What we first discover'd was, that all the purple Spots on the Back were prominent, that they were not simple Discolourings of the Skin, as might have been imagin'd, but each was an oval Scale, or a Kind of Shield, elevated above the Level of the rest of the Surface, and arm'd with a sharp but short Spine rising from its middle. As we continu'd the Observation, we saw that the Creature had the Power of Elevating or Depressing these Spines at Pleasure; and they seem'd capable of being used not only as offensive but defensive Weapons, in particular against the last describ'd Species, which though the constant and almost universal Prey of this when in the Way of being attack'd, might otherwise have attack'd it on the Back, as it often has the Courage to seize on Creatures larger than it self, and have devour'd it, without any Danger from Weapons situated only on the under Part of the Body.

This was all we had Opportunities of discovering on the Back with these Glassses, and the Bigness of the Creature render'd it inconvenient to use those of much greater Power; but on turning it over, there appear'd much more Field for Admiration. We here discover'd at one View the Instrument of Destruction, and an Apparatus for the securing and holding the Prey, which we had no Idea of. Many of the  
Animals

Animals of this minute Class are either wholly destitute of Eyes, or have them so minute, that the best Apparatus does not distinguish them: in this Creature, however, it is otherwise; at some small Distance from the Verge of the smaller or anterior Extremity of the Body, there stand on the under Part two large prominent Globules of a jet Black, and of a glossy Polish; they are moveable in their Orbits, and are undoubtedly Eyes. Between these, and at a small Distance below them, there arises a large pyramidal fleshy Body: its Base is affix'd to the Skin under the Eyes, and extends transversely almost from the one to the other of them. Its Diameter is about equal to a third of its Extent in Breadth; and at the smaller End there is affix'd to it a brown, and seemingly firm and hard Body, very slender, of a Length equal to three Times that of the pyramidal Base, and pointed, and very sharp at the End. Its Surface is glossy, its Figure conic, tho' the Base itself is but very slender, and there run from it two transverse Processes on each Side, these stand in Pairs, and their Direction is perfectly horizontal. The Pair next the Extremity are short, but the others are plac'd at some Distance above them, and are considerably long; they are all of the same firm Substance with the Proboscis itself, and of the same Colour. Down the Belly, on each Side this Proboscis, which in its usual Posture is apply'd closely to it, there run two Series of Filaments, which serve in the Place of Arms, Legs and Fins.

Fins. At some Distance from these there are placed also on each Side, in the same Direction, two other Series near one another, and near the very Verge there run also on each Side two others; so that the Creature has no less than twelve Rows of these Limbs, which may be call'd with equal Propriety, Legs, Arms or Fins, for they occasionally act in the Office of one or the other. The Rows of these which are nearest the Middle are shortest; the others are gradually longer to the Verge; and though there are constantly two Series running almost close together, those of the adjoining ones are not of the same Length, but the remoter from the Centre of the Creature are the longer. The Extremities of all of them are forked and sharp, and one of the Bifurcations, which is the shorter, seems moveable, the other is absolutely a fix'd Point.

These not only serve in the progressive Motion of the Creature, whether on the Bottom, or in the Fluid, or for the suspending it in Equilibrium in it; but their great Use of all seems to be the securing the Prey. The Weapon for Destroying and Feeding is the Trunk or Proboscis just mention'd; but the Creature being slow in its Motions, and unweildy, Nature has provided in a very uncommon Manner for its securing the Prey that it has once struck, which if it got away, it would have no Power to overtake; and though it died of the Wound, would have no Advantage from it.

It was with some Difficulty, and after a great many fruitless Attempts, that we at length saw the Manner of its seizing and securing its Prey; as soon as it comes within Reach of a proper Animal it erects the Trunk, which before lay in a longitudinal Direction on the Belly, the whole pointed or brown Part is plung'd into the Creature, and the Point often reaches through. The two Pair of transverse Bars arising from it, enter with the Force of the Stroke, and by the least Turn in the Direction of the Head, as they are remov'd out of the Direction in which they enter'd, nothing but the tearing a new Way for them through the Flesh of the Creature, can give the Trunk an Opportunity of getting out again; this alone would be one Way of no little Power of fastening the Prey. But as the Creature could have no Means of overtaking it again, if it should get loose; and as the whole Strefs of the holding it lying thus on the Trunk, that necessary Engine might be broken by some more boisterous Animalcule, and all Means of Feeding would be lost with it, Nature has added the Assistance of all these Series of Legs.

The Moment a Creature is struck by the Trunk, the Sides of the Body are bent inward, and the largest Legs, or those of the outer Series, are brought to bear upon it, and to enclose it so, that it is fix'd in a Direction parallel to the Length of the Body, and very close to it; when it is in this Situation, the Legs of the first Series came into Compact with it, and one of the  
Points



Points of each strikes into its Body, while the other presses it upon the Instrument that gives that Wound. When it is thus far fix'd, all the others by Degrees come in Play; they all gradually fix themselves to it in the same Manner as the first, and one of their Points is plung'd into the Flesh, while the other presses the circumjacent Part close. When the last Series of each Side have thus fix'd themselves, the Verge of the Body all along lays itself close to the Back of the Prey, and adds to the general Pressure. We are told of the Bear, and some other of the larger Animals, that they will take another Creature between their Legs and Breast and squeeze it to Death; but this is vastly more eminent in the Œconomy of this little Animalcule. The unhappy Victim is squeez'd close to the Body, transpierc'd with many hundred Wounds at once, and perishes doubtless on the Instant. All this Pressure would not indeed be necessary for the retaining any more than for the destroying the defenceless Creature, which is the most frequent Prey to the Animalcule which has the Power of it: there are other Ends to be answer'd by it. That Creature never gnaws the Flesh of what it preys on, it only sucks their Juices, and consequently it feeds only by Means of the Wound first given by the Trunk; the Pressure, which is so universal therefore on the Body of the Prey, serves to the useful Purpose of forcing up all the Juices from every Part to that very Place where the Wound was  
inflicted

inflicted by the Trunk, and where only the Creature can prey upon them.

I have observ'd that this Animalcule sometimes remains suspended in the Water when it has struck its Prey, but more usually plunges down with it to the Bottom; or to express it more accurately, sinks to the Bottom; for there is no Force in the Motion. By a Course of Observations on several of them feeding at large in the Water, we found that this was always varied, according to the Size of the Creature which it fix'd upon. If that were smaller, the Wound inflicted by the Trunk was alone sufficient to destroy, and the Trunk alone was sufficient to detain it. The Creature then let it remain in the Posture in which it had been struck, and used its Legs as Fins, to support it in the Fluid by their Motion, while it suck'd the Juices; and when it had done so, it shook off the empty Skin, and remain'd in its Place with all Composure. If, on the contrary, the Creature on which it seiz'd were large enough to be boisterous and troublesome, the Moment the Wound was given the Limbs all clos'd upon it, and the very Sides of the Body turning over it too, there remain'd no Power in the Creature of supporting itself, but it necessarily fell to the Bottom with the Victim enclos'd by its whole Body; and in this State, while feeding at its Leisure, and indulging in the Repast, it is impossible to know it for the same Animal. It appears in this Situation no more than a shapeless

less lifeless Lump of Matter of an oblong Form, and irregular Surface. I had seen several of them in this State during the first Periods of this Observation, and knew not what to make of them; but when we trace Things to their Origin, it is easy to understand them in all their Changes. I kept my Eye now upon some that I saw descend in this Manner with their Prey till they had done feeding on it: this was not perform'd with that Rapidity which is usual in the Insect Class on such Occasions; the Creature seem'd to understand it not simply as an Act of Necessity, but of Indulgence, and continued at it as an Epicure would at his Dinner. When this was done, however, the Body unfolded itself by Degrees: The Sides first expanded themselves to their usual Form, the Legs next shook off their Hold, and lastly the Trunk was disengag'd; off drop'd the mangled Skin, which had before been distended with the Body of the Animal, and the Destroyer, after waving the thin Verge of its Sides about for some Moments, and vibrating its Legs to recover their usual Motions, from which they had for some Time been interrupted, rose again by a slow Motion to the middle Region of the Water, and there without giving itself the Trouble of seeking after its Prey, or being under any Impatience for it, was ready to plunge the fatal Weapon into the Body of any Thing that threw itself in the Way.

Such

Such are the Œconomy and Management of four of the five distinct Series of Inhabitants of this little Puddle, the fifth and largest remain'd yet to be examin'd; and as we had occasionally seen something of its Form and Manners, seem'd to promise more than all. We have naturally so difficult a Conception of the Degrees of Magnitude between Objects in themselves so minute as to be all vastly below the Cognizance of the unassisted Sight, that without some Precaution it will be natural to suppose after we have been here speaking of four Kinds of Creatures, progressively larger, and much larger than each other, that the fifth, when it is declar'd to be much bigger than them all, must be of some considerable Size. It is necessary to obviate this, before I set out in its History, this gigantick Creature, as it is in Comparison of the rest of the Inhabitants of the Fluid, is yet so small, that were it an hundred Times bigger, it would not then be large enough to be visible to the naked Eye. Such and so extraordinary is the Power of the Combinations of Glasses in the present Microscopes, that they discover to us not only a Multitude of Beings otherwise invisible, but even among these there are numerous Series larger and smaller the one than the other; and as we find still new Series of them undiscover'd by the Glasses of smaller Power when we apply those of larger, we have no Reason to suppose, that the best we know how to provide, shew us the Extremes of this minute Creation: but as the  
Telescopes

Telescopes of greater and greater Power discover to us more and more of the fix'd Stars, un-  
seen through the others, till the whole Region  
of unbounded Space seems set with more and  
more remote; so it is probable, that he who has  
thus fill'd Immensity of Extent with Suns and  
Worlds, has, as Magnitude is to him nothing,  
equally peopled every Particle of these Fluids  
with still more and more minute Orders of  
Beings, much farther down in their Gradations  
of Smallness, than any Apparatus of ours can  
shew them.

It became necessary to adapt a Combination  
of Glasses of still smaller Power than the other,  
for the taking in the whole Form and Motions of  
this largest of the Animalcule Brood, but it also  
became necessary afterwards to adapt again those  
of much more Power for the investigating its  
Parts and their Operations, and its singular Man-  
ner of Motion. On a View of the Creature in its  
free State, in a sufficient Quantity of the Fluid for  
its performing all its Motions, and with a Power  
of Magnifying, that shew'd it very distinctly if  
less enlarg'd than is usual on such Occasions, we  
saw it of a very singular Form and Appearance.  
Its Body was of the Figure of a Crescent; the  
Part which mov'd forward, and consequently  
where the Head was situated, was the convex  
Side, or Back of the Crescent; and between the  
Horns, in the very middle of the hollow'd Part,  
there grew a moderately long and cylindrick Tail,  
thickest at the Base, and forked at the Extremity.

The Colour of the whole Animal was a pale green, except that the Verge of the convex Part of the Crescent was redish, and seem'd thicker than the rest, and the whole Tail was white, but with a Tinge also of reddish or Flesh Colour. It mov'd tolerably quick, and turn'd about at any Time with great Ease; and whenever it was in Motion, the Tail was thrown about continually very swiftly, and in a great Variety of Directions, and that much in the Manner of the Tail of a Dog, that is in a good Humour from one's playing with him.

The Apparatus, which gave us this general View of the Animal and its Motions, discover'd only two of the subordinate Series, and those but very imperfectly; they rather seem'd like animated floating Atoms, than any regularly form'd Animals. It was easy to see that the Creature, which was the proper and immediate Object of our Observation, was all this Time feeding, and that in a very ravenous Manner, but it was very difficult to conceive by what Means this was done, as well as how or by what Kind of Apparatus it perform'd its Motions. We saw it float about and change Place in any Direction with great Facility, tho' we discovered no Motion in any Part of it except the Tail, and that by no Means such as could be suppos'd to occasion the Progression; and when it chose to rest, which was generally as it seem'd for the Sake of feeding with more Ease, it fix'd itself by applying the forked Extremity of the Tail to the  
 Glafs;

Glass; and what was a very surprizing Sight, tho' it took no Pains, that we could perceive, to draw the other Creatures to it, all that were large enough to discover themselves to this Apparatus, occasionally came up; and threw themselves with Rapidity into its Mouth.

This was a Circumstance that appear'd at this Time no less surprizing than what we are told of Rattle Snakes Power of Charming, as it is call'd, the Birds and smaller Reptiles by its Eyes, till they fall or run into its Mouth. But whatever may be the Reality in regard to that strange Story, the whole Miracle in this other Case was soon explain'd to us, and we were convinc'd that it was only a Deficiency in our Organs, and the Apparatus we had at that Time put together to assist them, that occasion'd the apparent Singularity.

On adapting a large Set of Magnifyers, and getting one of these Animals within a smaller Compass of the Fluid, and with still some of its Prey about it, we discover'd that the whole anterior Verge of the Body was supported in its convex Form, by a Rib or Ridge of a rounded Shape, and a solid Substance, and of a red Colour; the posterior or hollow Verge was supported also by a blue Rib, but smaller, and the Tail itself seem'd a Continuation of the Matter of these Ridges, only quite white, as the under Ridge was paler than the upper. The Body itself was now seen to be flatted, and compos'd as it were of two fine Membranes of a very bright yellowish green

What we farther discover'd, while the Creature was in this uncomfortable, tho' favourable Situation for us, was, that its Mouth was a vast Opening in the very Front of the prominent Part of the Crescent; but this, as it was some little Way on the under Part of the Body, was more easily seen in this View, than it could have been from above, when the Back was upward. The Creature at length disengag'd itself from this painful Posture, and swam about in the usual Way with more than ordinary Rapidity and Vivacity; at length it on a sudden precipitated itself to the Bottom, and expanding the forked Extremity of its Tail to fix it to the Glass, shew'd us a Mechanism in that Part, which it was impossible for us before to have any Idea of.

The first Motion towards this fixing it to the Glass, was made by extending the two Points of the forked End of the Tail to as much Distance as possible, so that the very Base of the Bifurcation approach'd the Bottom; from this Base, or the Centre of the two Ramifications, there was now produc'd a third: this was very short in Comparison of the other two, and of a singular Figure. As they were cylindrick, this was of a truly conic Form, and hollow at the Extremity, which answer'd to the larger Part or Base of the Cone. This Cavity was surrounded by a flat and somewhat thick Rim, from which there ran every Way a Number of very slender Filaments, continually in Motion. It was but a little Time before the  
open



open End of the Cone was fix'd down to the Glafs; and as soon as it was so, the Filaments spread themselves in all Directions from it, in the Manner of Roots, and fastening themselves down firmly to the Glafs, their whole Length assisted greatly in preserving the Extremity of the Cone in its Place. As soon as this was thoroughly fix'd, the other two Ramifications form'd themselves into a Kind of arch'd Figures, one on each Side of it, and expanding a little at their Extremities, fasten'd themselves in the same Manner as the first had done, and shew'd, what had not at all appear'd before, a Number of Filaments surrounding the Verge of each of them in the same Manner as those of the Middle of the Ramification; fixing themselves down in the same Manner to the Surface of the Glafs, and assisting in holding the Bodies, to which they severally belong'd, in their Places.

We had hitherto seen this Creature, though much the largest of all the Inhabitants of the Fluid, swimming about in perfect Peace among them; and while they were devouring one another by Hundreds, never meddling with any. We had admir'd the different Disposition of this whose Size qualify'd it for being a Devourer of the largest, and a much more universal one than any others, while it had yet shewn no Disposition to do Mischief. It was singular, that a Creature which had swam about so inoffensively, should have fix'd itself in order to its Feeding; and however little we might have ex-

Colour, with a filky Glofs on them. We now found that the whole Verge was elastick, and the Tips of the Crescent in particular were capable of Motion, but that it was very quick, and they instantly recover'd their Form again. The Creature was all this Time in Motion, and these sudden and irregular Vibrations of the Points of the Crescent seem'd no more capable of producing that Motion, than the Concussions of the Tail. By great good Fortune the Creature engag'd itself in a painful Manner between the Edges of the two Glassess in which it was contain'd, with the Fluid about it; and in its Struggles to get loose, found itself on its Back. We had not doubted but that we should find some Mechanism on its under Surface for the Performance of its Motions, though the upper Side discover'd none. Our Opinion was soon found to be just. We now, that the Creature was in this favourable Posture, and in violent Motion to release itself, had an Opportunity of seeing not only what was the Apparatus by which it mov'd itself, but the Manner of its applying that Apparatus. We saw, that the whole under Surface of the Body was furnish'd with a peculiar Kind of Appendages, which by their Form could have no Title to the Appellation of Arms or Legs, and were indeed no other than real Fins, analogous both in Use and Structure to those of Fishes, and resembling them also in some Degree in Shape.

There

There were no less than three Rows of these, dispos'd in Series exactly according to the Shape of the Body. The first Series consisted of the largest, and was situated at a small Distance below the Rim of the Body on its anterior Part. The Second consisted of smaller Fins, of the same Figure with those of the First, but of a thinner and tenderer Structure, and was plac'd very exactly in the Middle of the Body: and the Third had their Origin near the posterior Verge, and were so short as not to overhang it, so that they could not be seen from above, any more than the others.

Each Fin was of an oval Figure; the smaller End of the oval being join'd to the Body, and the larger or opposite Extremity terminated by a thick Rim or Ridge of a different Colour from the rest. Each was fix'd to a Kind of moveable Hinge at the Base, and had there a fleshy, or rather to Appearance a grisly Protuberance of a rounded Figure, and from this there ran six or eight Ribs of the same Substance, and in some degree of the same Colour, along the whole Fin. These serve to support the Fin, and they terminate at the Verge, uniting themselves to the prominent Ridge or Rim, which seems of the same grisly Structure. The Substance of the Fin seems to be membraneous, and in all Respects like those of Fishes; and the whole is moveable at the Base as those are: the general Colour of the Fin is a very pale green, but the Ribs are white with a little Blush of reddish.

pected, or imagin'd this at first, we soon found it to be the Case.

The Creature was no sooner firm in its Place, than we saw protruded from its anterior Part two large and oblong Bodies, out on each Side of the Mouth; these were no sooner in Sight, than they put themselves in Motion, and surpriz'd us with the exact Resemblance of a Couple of Wheels, like those of a Water-Mill, turning round with a surprizing Rapidity, and each making its Revolution inward, or in a Direction toward the Mouth.

The Consequence of this extraordinary Motion was, that two Currents were form'd in the Water, which between them took in the whole Quantity. The Motion was too violent not to carry with it all the Animalcules, of whatever Kind they were, that came within its Influence, and it was incessant. In the Course of a few Moments, every Drop of the Fluid came within the Verge of the immediate Whirl, and as both the Wheels turn'd inwards, it was a Consequence that every Drop which did so was thrown into the Mouth, which was all this while kept wide open between them. In this Manner the whole Quantity of the Fluid, with all the Animals it contain'd, pass'd several Times in a Minute through the Mouth of this Creature, and it could as it pleas'd close the Jaws upon whatever of them it lik'd.

It would not be easy to produce a more striking Instance than this of the Manner in which the Devourers of the Works of Nature prey on  
one

one another. Here were before us in the same little Portion of the inhabited Fluid, four different Series of Beings feeding upon and destroying one another by various Means, and in different Manners, and at length appears a fifth, which, but in Pastime, without the Trouble of Pursuit, draws in the whole Multitude, great and small, the Devourers and their Prey, and takes them into his Mouth to swallow or discharge them just as he pleases.

It is in Compliance only with the common Custom, that I have hitherto call'd the Apparatus of this Animal, for forming a Current in the Water, by the Name of Wheels. Several Species of Animalcules beside this have the same Organs, and use them in the same Manner, and the rude Observers of earlier Time have taken them to be Wheels, and even call'd the Creatures from them Wheel Animals. 'Tis odd that it should not occur to these Writers, that in order to a Wheel's performing such an unlimited Number of Revolutions all one way, it must be detached entirely from all other Parts of the Body of the Animal; and that if so detach'd, it could not be nourish'd. Impossibilities and Contradictions of this Kind, however, cannot perplex those who do not see them. The Mechanism is in Reality of a Kind very different from that of Wheels, but it is singular enough, and greatly worthy Attention.

It was not till after many Attempts that we succeeded in getting one of these Animals in  
such

such a Situation, as that it must soon perish by the Evaporation of the Water, and that in a Way in which we should see the last Motions of its Apparatus. Under this favourable Circumstance, which was owing to the very narrow Cavity between the Edges of a small double Concave Glass; we at length had one fix'd for preying, and intent upon it, while the Water pass'd very quickly away from under it. The Creature many Times drew in the whole Apparatus during the first Approaches towards its being left dry, and we were in Fear it would die with them, retracted into its Body, but the Event was more favourable. 'Tis a Sort of Cruelty to take Advantage of the dying Agonies of these minute Animals, but it is often only in these that we have an Opportunity of distinguishing their Structure. This was perfectly the Case in the present Investigation; the Creature that had at the first Threat of its Destruction drawn back the whole Apparatus, protruded it forth again at Times, giving it a slower and slower Motion, which also tended not a little to our making the Discovery; and at length it died with both of them thrust out.

During the Moments of the slower Motion of these imaginary Wheels, we discover'd that the fleshy Protuberances, which we had at first seen protruded on each Side near the Mouth, were of a rounded Figure, and each furnish'd with a great Number of elegantly form'd and jointed Arms. We soon discover'd, that the  
fleshy

fleshy Tubercles on which these grew were stable, though they by Means of their Joints were continually in Motion. It would not have been easy either to count the Number of these, or to discover their Form and Structure, unless they were in some Degree of Motion, though the usual Rapidity of their Movements render'd that equally impossible. In their more languid Moments, it was easy to count that each Tubercle had fourteen of these Arms, and every Arm no less than eight Joints. They were all largest at the Base, and pointed at their Extremity, and were all the Way along beset on each Side with a Multitude of Filaments in the Manner of the Plumage of a Feather, but with this essential Difference in Favour of the Animal, that as those Filaments are all fix'd for ever in their horizontal Direction, these were capable of moving at its Pleasure, and of answering very important Purposes by that Motion.

As the Movement of the imaginary Wheels was inward from both Sides of the Mouth, we soon discover'd also that the eight Joints of each Leg were all form'd solely for bending in the same Direction. The Body of the Leg, or the whole intermediate Space between every two Joints, was of a convex Form on the Back, and concave at the Front, or on the inner Side. The Joints had the Appearance of so many Balls and Sockets cover'd with a thin and unctuous Membrane, and form'd for the readiest  
and

and easiest Motions; and it was apparent, that the Base of every Filament of the Plumage also had an Articulation of the same Kind, by which as the whole Body of the Limb, could be drawn forward and in no other Direction, so the Plumage in every separate Part could be mov'd inward, and in no other Direction.

When we had thus far inform'd ourselves of the true Structure of these Limbs, our whole Observation was directed toward the Manner of using them, by which the whole Congeries seem'd to form the Appearance of a Wheel. While the Motion was perform'd in its full Rapidity, a Discovery of this was impossible, but in the languid State of it, under which we continu'd the Examination, it was easy. We saw the Arms all in Motion at once, tho' this very slowly, the Base on which they were fix'd, or from which they grew, remain'd all this Time perfectly still; and indeed, having no other Articulation, it is wholly incapable of any Motion other than that by which the Creature draws it in, or thrusts it out at Pleasure; the Arms were in their Posture of Rest, that is they stood erect, and their Filaments or Plumage, if the Expression may be allow'd, for no other can express the Thing so well, were in a drooping and unexpanded Posture. 'Tis from this State of utter Rest that we may best begin an Account of their Motions. In an Instant the Plumage became all erect, or rais'd into its firm and stationary horizontal Posture; the Arms now made a very different Appearance  
from



from that under which they were first seen; each was with the Verge of its thick Plumage of at least four Times its former Diameter; in this State they were all bent downward and inward, as a Man may close together his extended Hand by drawing the Points of the Fingers down into his Palm; as all the Joints of the Fingers will be seen to assist in this Motion, so all the more numerous Articulations of the Limbs of this Creature assisted in the same Manner. The whole Plumage continu'd expanded all the while, and the Limbs in fine became roll'd up together as it were. This Motion, from fourteen such Arms at once, could not but drive forward all the circumjacent Fluid in the Direction in which they mov'd, that is from the more distant Parts toward the Mouth, and the Limbs of the other Pro-tuberance, for those of the two seem always to keep Time with one another, acting in the same Manner, at the same Instant, as much of the distant Water, from that Part of the Space behind this Series was thrown toward the Mouth, as on the other Part from the other.

When the Limbs were thus folded, the next Thing was the Explication of them. In this we saw them gradually recover their former Position, as if from a mere Act of Restitution, without any impulsive Force, and in this unwinding or drawing back the Filaments at the Edges, forming what I have call'd the Plumage of the Arms, were not extended and rigid as they had  
had

had been in the closing, but they hung lax and fell inward. The Arms were no sooner in their erect Posture again, than the Filaments of the Plumage became rigid, and were restor'd to their horizontal and firm Direction; in this State the Arms were all clos'd again, and the Water driven before them as at the first.

These Motions were repeated a Multitude of Times before us, and that so slowly and deliberately, that it was very easy for us to distinguish every Article, and every Part of the Motion; and from this Observation it was easy to infer, that no more was requir'd than a very rapid Motion of this simple Kind, a quick successive closing and unfolding of these Arms to deceive the Eye in the Particulars, and to form a continued Current, by what should appear thro' the Misrepresentation of that Rapidity a circular or wheel-like Motion. In the healthful State of the Animal, when these Organs are us'd in Search of Prey, the closing and unfolding of the Arms is perform'd many hundred Times in a Minute; and as the Act of Closing from the expanded Figure of them during that Act is much easier seen than that of unfolding or drawing back the Joints, that is the sole Motion that is perceived by the Eye. The Expanse of the Arms, by means of the Plumage, takes in a large Volume of Water, in Proportion to the Bulk of the Animal, and the quick and successive Repetition of this throws the whole Quantity of the  
Water

Water into Motion, and forms a Current. In the mean Time the drawing back of the several Joints, or recovering the Arms to their State of Erektion, is attended with scarce any contrary Direction to the Fluid as it is perform'd more gently, and the Volume of Water press'd against is but equal to a fourth of that agitated by the same Arms in their Descent when the Plumage is expanded; and even this fourth Part of the Diameter of the Arm in this State passes much more easily, and with less Resistance or Disturbance thro' the Water as it is of a convex Form, whereas the whole of the other inclines to a concave.

By this simple Mechanism, analogous to that of many other of the Animalcules which inhabit the Waters, it is that the imaginary wheel-like Motions, not only of this Species but of all the others of those call'd Wheel Animals, for I have examin'd them all, is perform'd: and thus easy will it be found in many other Cases to reduce what is made ridiculous and absurd, by the Misrepresentation of those who have attempted to understand it with unequal Faculties, to the regular Laws and common Forms of Nature, where proper Attention is guided by a competent Understanding in the Research. Nothing can so deeply scandalize any Branch of Knowledge as the asserting Impossibilities in any Part of it; and it is too long that this pretended Wheel Structure in the Animalcules of this Kind, has been an Opprobium to the Naturalists.

The Quantity of Animalcules of other Kinds, which we saw by this Mechanism thrown every Instant into the Mouth of this Creature, during its State of Health and more rapid Motion, is inconceivable; but the Destruction was not so great as might have been conceived from the Apparatus: the Mouth, tho' often fill'd, seldom clos'd. The far greater Part of the Creatures thus thrown into it were instantly thrown out again, and only such as were the more immediate Objects of its Choice were retain'd there. As the Creature grew languid, and the Motions became slow, more of them were destroy'd by it, for tho' the Revolutions of the Water were less frequent, the Jaws clos'd much oftener, and at last, toward the End of the Creature's Life, perhaps from Compulsion rather than Choice, almost continually. When the Water was almost entirely gone, the Creature loosen'd its Tail from the Glass, and after a Struggle, which seem'd a vain Effort to follow the departing Fluid, died with the Tubercles in their protruded State, and the Arms in a middle Position between that of their Extension and their entire Closing. The Filaments of the Tail are also visible, and the whole remarkable Apparatus of Fins on the under Part of its Body. I preserve the Specimen in this Condition, and esteem it the happiest Sample of an Animalcule I have ever been possess'd of.

E S S A Y XIV.

*On an Insect of peculiar Form and Structure  
inhabiting a gelatinous Sea-plant.*

**I**N one of the first of these Essays I mentioned a vast Variety of marine Productions, which I brought up to Town from an Expedition to the Island of *Sheppey*. The Misfortune of having too many Objects for Observation is often, that we pay but an imperfect Regard to one, to get at another; like a Child, who hurries over the Pages of a new Book to get at the next Picture. When we have a more resolute Attention to the first Subjects of our Observation, we lose the Opportunities of examining the others, which perish in spite of our best Care, while we bestow our Time on that. This was the Case, in regard to the greater Part of those curious Things, as well of the Animal as the Vegetable World, which I had brought up from this Journey; but as I knew where to send for them again, I readily forfeited the present Advantage to the pursuing the Investigation of the first Object I had seized upon.

I could not but recollect, among the many curious Bodies of this Parcel, that I had been strangely surpris'd at the continual Motion of certain Appendages to a Sea-plant; and now made no doubt of their being Animals, inhabiting or making their Way into it, though at that

Time it had not occurred to me. The Plant was that gelatinous kind of Fucus, as our Writers express it, which is called the Sea Ragged-staff. I recollected that it was very frequent about the Shores of the Island, washed up by the Tides; and I sent Instructions for the taking up a Quantity of it, and sending it by one of the Hoys, in its own Element, and in such a Manner, that it might come with as little Injury as possible. The Orders were easily fulfilled, and I received several fine Specimens of it.

What I had at first observed of it, I still saw in these Pieces. The Plant itself is of a very rude and irregular Form; but its common Branches are six or eight Inches long, and from a Quarter of an Inch to three Quarters of an Inch in Diameter. Its Substance is consistent, but soft: It seems a mere hardened Jelly. Its Colour is a pale Brown. Its Surface is covered with irregular Protuberances, and the whole Plant makes a very singular Figure.

Beside these larger Protuberances, I had originally seen on it a Number of very minute and delicate Bodies, having much the Appearance of Feathers, the Quill-part of which was stuck into the Substance of the Plant: These were in continual Motion, waving backwards and forwards, as if under the Impulse of some Tremulation in the Water. I soon discovered that the Motion was continued, when the Water was ever so quiet; and was easily brought to believe, by this and the  
whole

whole of their Appearance, that they were not a Part of the Plant, but some Animals which inhabited it, or, at least, made their Way into it at their Pleasure.

Of all the Insect or Animalcule Tribes which we see inhabiting either the natural Cavities of Vegetables, or the accidental ones of Stones, and other solid Bodies, the Part that is protruded forth at the Verge of the Hollow, is in general the Head: This is occasionally thrust out and drawn in; and usually has its Number of Limbs or Horns, or some other Appendage of that kind, about it. The least Disturbance of the Fluid generally occasions the drawing in of every apparent Part of these Animalcules: But in this Case it was otherwise. A very rough Motion given to the Vessel, in which the Plant was contained, had no Effect; and even the touching several of them, one after another, afterwards, did nothing more than occasion a brisker Motion in them; not one of them disappearing either on this or any other Occasion of Disturbance.

On applying a Piece of the Plant, cut off, with one of the Creatures adhering to it, before the single Microscope, no Appearance of Legs or Arms, or Head, or any other distinct Part of an Animal appeared: The whole that could be discovered was, that there ran a rounded Stem up the Middle; and that, on each Side of this, there grew a thin and pellucid Membrane, which was folded in a Multitude of Wrinkles; and, beside its common Motion with the whole Body

of the Animal, had its Vibrations and Undulations of its own. Had it not been for these, it would have been natural to suppose it a Part of the Plant; but as they determined it a distinct Being, and that of the Animal Kingdom, it remained to disengage it, in order to see its whole Form.

The Individual, which was now under Examination, perished in the Attempt: But a little Caution, in repeating it on some of the others, disengaged four or five of them; and I had the Pleasure of seeing these swimming at Liberty in a small Quantity of Sea-water, which I had put into a concave Glass, and adapted to the double Microscope. It soon appeared, that the Part of the Animal which I had examined, as it remained fixed to the Plant, was the hinder Portion of its Body, the Head having been all the time deeply immerfed in the very Substance of the Vegetable. The whole Animal, as it now swam about, exposed to View, was of a very singular Form: It resembled still more a Feather than it had done in the first imperfect View. The Head, and some Part of the Body, which was nearly of the same Thickness with the Head, were rounded, smooth, and naked; and not ill resembled the Barrel of the Quill; and the rest of it, with the Membrane on each Side, the feathered Part.

There was no great Reason for determining this naked Part the Head, except that it was always carried forward in the Motions, and the whole of the Movements appeared to be made by



by the Tail, or edged Portion of the Body; the Membrane of which, vibrating about, caused all the progressive as well as the turning Motions of the Creature. Sometimes the whole hinder Part of the Body was thrown backward and forward, alternately, with great Rapidity: At others the main Trunk or Stem remained fixed, and only the Membrane itself moved, either in a vibratory Manner from Side to Side, or else by drawing together and expanding again; the Edges being occasionally drawn one to the other, and the Trunk inclosed, as it were, in a Case formed by them; and at other times the whole either partly or totally expanded. According to these different Directions, the Creature moved more or less swiftly forward as it turned to one Side or the other, or kept suspended without any Change of its Place.

The Portion of Fluid in which I had put these Creatures for Observation, was not salt Water of my own preparing; but some of the genuine Water of the Sea: It had come up in the Vessel out of which they were taken, with their Portion of the Plant: It was consequently full of Inhabitants of the Animalcule Kind, and we saw these preying upon one another incessantly, as is always the Case where there are of different Species. But these which were vastly superior to all in Size, and capable of swallowing up Multitudes of the largest of the Devourers at a Mouthful, never made an Attempt upon any of them, nor seemed at all concerned about

them; nor, indeed, could we distinguish any Organs for eating in the Creature.

Its whole Body was of an oblong Figure, rounded, and somewhat larger towards the Head than elsewhere. Three Fourths of its Length were edged on each Side by the Membrane, which was continued about the Tail, and terminated in a rounded Form. The naked Part of the Body, which we had no other Reason to distinguish as the Head, but that it was thrown forward in the Motions, was also rounded, but terminated in a sharp Point of a triangulated Form. The whole Body of the Creature was of a pale green Colour, and the Membrane white; and this triangulated Point, which terminated the Head, was brown, and of a seemingly boney Texture. We carefully examined every Part of the Body that was near this instrument; but could discover no Mouth, no Tentacula, no Eyes, nor Appearance of any Organs for whatever Purpose: And it was plain, that the Point or Instrument itself at the Head was firm, solid, and had no Aperture any where about it.

When we had examined the whole Animal as diligently as possible, without making out any Thing farther than what appeared at the very first Sight, we put the little Quantity of Water, in which those under our Observation were kept, into a somewhat larger Portion of the same Fluid; in which we also placed a Piece of the Plant, on which they had been originally found. They continued their Motions, and their occasional Rests,

Rests, as indolently in this State as they had done in the former: And we were despairing of making out any thing concerning them, when one of the Number, by perfect Accident, touched the Side of the Piece of the Plant. In an Instant it seemed new animated: It drew its whole naked Part of the Body backward along the Side of the Plant; and, receding to some little Distance, poised itself in the Water, and then darted forward with Violence. The Extremity of the Head being thus driven against the Plant, the Instrument with which it was terminated was forced into the soft Substance of it; and the Membrane, that edged the rest, continuing a vibratory Motion for some Moments, we found that Instrument making its Way still farther and farther into the Plant, 'till the whole Head and half the naked Part of the Body were immersed in it.

As we were observing this Process, another of the Creatures coming by Accident into Contact with the Plant, did the same, exactly in the same Manner; and, in a few Minutes, the other. It was evident, from the whole, that the Creature had no Eyes; that its Food seemed to be the Juices of this Plant; and that it yet had no Way of finding it out, but by perfect Accident: Nor was it easy to conceive any Creature more exposed to Injuries of all Kinds than this defenceless Insect, even after it had got at the Means of Life; the whole hinder Part of the Body being naked, and exposed, while the Head was immersed.

When the Creature had once fixed itself in this Manner, it seemed totally at Ease: The Body was subject to no Motions, except a gentle Vibration of the Membranes, which seemed rather by way of Amusement than intended to answer any Purpose; and the utmost Change that we could think we discovered in it, from time to time, was, that the Head seemed sometimes more deeply, sometimes more slightly, plunged into the Plant; but this it was hard to distinguish with Certainty. As we had hitherto discovered no Organs for eating in this singular Creature, the Curiosity of knowing in what Manner it performed that necessary Operation became a Subject, concerning which we were eager to be satisfied. We saw no Means of this, while it was fixed to the Plant; and on drawing it forth, ever so suddenly, there appeared no Change of Form, or new Discovery of Parts, about the Head. The first and most natural Opinion was, that the triangulated Point at the Extremity of the Head was a Proboscis, and open at the End, for letting in the Juices extravasated by the Wound it made; but on bringing it before the largest Magnifier of the single Microscope, it was found to be solid and close in every Part, and its Point inconceivably fine, but sharp, and without the very Appearance of a Hollow or Opening in any Part of it.

As the Plant was of a kind of gelatinous Substance, and in some degree transparent, we made a new Attempt of seeing the Operations of the  
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Creature's Head within it. We cut several transverse Slices from the thickest Part of the Stalk of one of the vigorous Pieces, where these Animalcules were most numerous; and though we destroyed many of them in the Operation, yet there was not a Piece in which we did not find one or more of them yet fixed, without Hurt, and in its usual Position.

We selected one of the thinnest of these Segments, on which there was fixed a single Animalcule, with its Membranes in Motion. On laying this in a little Water before the double Microscope, we saw a new and strange Scene: What we had observed of the Creature's plunging its Head deep into the Plant, and drawing it out again to a smaller Depth, by means of its Motion of the Membranes, and bending about the hinder Part of the Body, was not imaginary. The first Thing we discovered on this Examination was, that the Point of the Head kept no fixed Place in the Substance of the Plant, but was almost continually changing: Sometimes it was withdrawn nearly to the Surface, and at others plunged deep in; so that the very Part of the Body, edged by the Membrane, came in Contact with the Surface.

The thin Piece of the Plant that gave Opportunity, by its Transparency, of seeing this, was the Means of farther Discoveries. We had observed, from the first, an intestine Motion in the very Substance of the Plant; and on adapting a more powerful Magnifier, than that by which we had

had taken in the whole Body of the Animalcules at a View, we had an Opportunity of discovering at once what it was to which this intestine Motion was owing, and what was the Intent of the several Protrusions and Retractions of the Head of the Creature, whose Nature we were investigating.

We soon saw that the Motion, which we had at first discovered, without understanding to what it was owing, was that of Multitudes of Animalcules which inhabited the Substance of this gelatinous Plant, and roved about at Liberty in its Bed of soft Matter, feeding on its Juices, or its pulpous Substance.

We now had an Opportunity of seeing also, that the larger Animal fed as voraciously on these; that its sole Business, in plunging its Head into the Trunk of the Vegetable, was to get it among them; and that its Motions of Protrusion and Retraction were intended as nothing less than the bringing it into the Way of more and more of them. It is singular in the Oeconomy of these little Animals, that Nature, having ordained them as the Food to one another, has given them no Sense of Danger, nor any Inclination to escape it. The Animalcules of smaller Size, therefore, did not get out of the Way of this Devourer, and by that Means make it necessary for it to hunt after or pursue them; but when it had cleared away the Spot where it had been just feeding, it only became necessary to remove to another where there were more. The drawing nearer  
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the Surface of the Plant, from a Part farther distant from it, answered this Purpose; and, at the same time, was all that could be necessary toward the filling the unpeopled Spot again with Inhabitants, which abounded in all Parts of the Substance, and had nothing to do but to continue their usual Motions to get into it.

This explained the whole Oeconomy of the larger Animal, whose Life seemed spent in one fixed Spot of the Plant, and which performed no other Motions than the drawing its head more out, or plunging deeper into it. While it was preying at a greater Depth, the Parts near the Surface became filled with Inhabitants; and when it retreated to these, the Time it spent in devouring them was sufficient for the new peopling of the Place it had left, so that he needed only return thither for a new Supply.

Though we saw the Destruction in this View, we could not, without turning the Piece of the Plant with its other Side upwards, discover the Means by which it was performed. This unexpected Turn gave us an Opportunity of viewing the under Part of the Creature, of which we had hitherto seen only the upper, or Back. We now discovered, that the Extremity of the Head terminated in a Weapon, that was indeed solid and unperforated; but we saw, at some considerable Distance from the Base of this, the Mouth, which was a very long Fissure, situate not transversely, as in most Creatures, but in a longitudinal Direction; and though it was not capable of opening  
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to any great Width, yet of a Length that very well answered to the Deficiency.

It was no Wonder that we had not discovered this Mouth before; for, in the general State of the Animal, it is shut, and, at the utmost, can only be distinguished in Form of a longitudinal Streak or Line; but when the Prey is in Reach, or when, as in the present uneasy Situation, it was gasping, and in Agonies, the Opening was frequent. It was not long before the Creature recovered its natural Situation, and got its Back upwards; but the Time it had continued in the other Posture, and the Agonies it had suffered while in it, were sufficient to give us a fair Opportunity of seeing all that regard its Organs of feeding.

When a larger Magnifier has once discovered an Object, one of smaller Power, through which it would have been difficult to have seen it originally, will often keep it in Sight. We now adapted Glasses of a middle Power, between those which had now discovered to us the whole Number of Inhabitants, and those which had from the first shewn us their Motion, in a Manner, unconnected with their Forms; and these continued the View of them sufficiently distinct, and gave us an Opportunity of seeing all that passed in regard both to them and the other.

I have observed that the Segment of the Plant, inhabited by these Myriads of moving Atoms, was transparent. The Body of the larger Animalcule is so too; and through both we could  
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with this Apparatus see, though somewhat disturbedly and indistinctly, what passed. We saw the Creature, tired of its uneasy Posture, at first recover its former Position, and instantly after dart itself forward, by means of a Motion in the Membrane about the Tail. We could distinguish not only that the Place it thus got into was inhabited by a sufficient Quantity of the lesser Animals; but could see them occasionally slide under its Head; and always, at the same Instant, we could discover, through the transparent Matter of the upper Part of the Head, the opening of the longitudinal Fissure, which we had before discovered to be the Mouth: We could see this open to take in the Victim, close instantly upon it, and open no more 'till a new Call of the same Kind demanded it. The Use of the Instrument at the Extremity of the Head is, indeed, no other than that of making an Aperture for the letting in that Part of the Animal; and the whole Business of feeding is performed in this easy and familiar Manner. The Part of the Plant, where the Creature has taken its Place, is sufficiently stored with Food for it for a very considerable Time; and when its Devastations have thinned it, so as to threaten a Want of Prey, there is nothing to hinder it from changing Place; withdrawing from the Spot where it has hitherto been, and piercing the Surface in a new Place.

When we had thus fully informed ourselves of the Nature and Qualities of this larger Insect, which

which had been the immediate Subject of Investigation, it was natural to turn our Eyes toward the smaller Animalcules, which served as its Prey, and which we had by perfect Accident discovered in the examining its Motions.

The Place of Habitation of these Creatures, in the very Substance of a Plant, is sufficiently singular to attract the Attention. They live not confined to any one Part of it, but rove about at their Pleasure from Place to Place in it. The Plant itself is composed of a thick and somewhat tough outer Membrane, containing a softer pulpy Substance within, which is separated by and interspersed with a Multitude of Fibres. We soon perceived, that the Food of these little Creatures was the pulpy Matter or Jelly contained in the Stems; and that their Motions were not performed by swimming, or otherwise moving in it at Liberty, but that they crawled upon these intermediate Fibres.

The Fibres themselves were drawn, in the Manner of diagonal Lines, from Side to Side of the Plant; and, though simple and somewhat thick at the Place of their Origin, they became thin and ramified before they joined the opposite Sides. We saw the Multitudes of these little Creatures climbing up and down them in various Directions, and frequently tumbling from them, and in danger of being lost in the intermediate Pulp, 'till they sunk into Contact with some other Fibre. All our Endeavours to make out their Form, while in this State, were in vain: The  
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Matter in which they moved was too thick for their finer Parts to be distinguished through it. I took out a Segment of the Plant, and laying it on a flat Plate of Glass in a little Sea-water, pressed it with a Hair-pencil 'till I had forced out the pulpy Matter in great Part from the Membrane that contained it, and blended it with the Water. I could easily suppose, that, in so rough an Operation as this, I had destroyed a great many of the Insects; but I was not disappointed in the Supposition that some had escaped: Among the crushed and mangled Carcasses of thousands, there swam or crawled some that seemed quite unhurt. The Fluid in which they were, was yet too thick and foul however for a distinct View: The pulpy Matter of the inner Part of the Plant had fouled the Water to a strange Degree. We diluted it, by mixing more and more, 'till at length we saw some of the Subjects of our Observation alive, and in Motion, in a very clear Liquor, and every way in a Condition to be examined. A Drop of this was removed to a fresh Plate of Glass, and the three or four Animalcules, which were in it, were found in a perfect and vigorous State.

Let it not seem tedious, that, throughout the Course of these Essays, I am particular in describing the Methods used to get at a proper View of the Subjects which are treated of in them. There will be this Advantage attending it, that it will render the Microscope familiar to those who are unacquainted with it, and teach

them the Manner of going about Things, which otherwise they never could arrive at the Method of doing. The Creatures described in these Essays are all of them newly discovered: Not one of them has been described by any Author, or seen by any Observer, that I have learnt. I would leave the Way to follow me in the Examinations open to every body, and as easy as possible; for I should be very sorry, that the Unacquaintance of the future Examiner with the Way of using his Instruments, should make him suspect the Veracity of these Accounts. This is a Fate that has often befallen the best Writers on these Subjects, and that has not a little discredited all that has been written of the Uses and Discoveries of the Microscope with too many. Those who will examine the Bodies I have mentioned, in their proper State, and use the Means I have described in the Prosecution of the Investigation, will never fail to find the Objects as I have represented them: And as I have purposely contrived, in one or other of these Essays, to take in every kind of Object, the Man who has followed me in these, and got the Method of changing his Glasses and whole Apparatus in the several Ways I have directed, on the different Occasions, will find he has not only made himself perfect in the Manner of observing this particular Set of Objects, but all others; and will find the Microscope, in a manner, a new Instrument to him; a Source of a thousand Pleasures, which

which he may before have been wholly without the Means of enjoying.

The Animalcules which had been with all this Difficulty separated from the Contents of the Sea-plant, and preserved in a Drop of clear Water, were now under the Examination of the double Microscope: They did not seem very quick in their Motions, tho' there was no Appearance of their being hurt by the rough Means of the getting them loose: They mov'd but very awkwardly when they attempted to suspend themselves in the Body of the Fluid, and when they were on the Bottom, their Situation did not seem easy to them. It may be remembered, that I mention'd their general Motions to be perform'd along certain oblique Fibres, which run from Side to Side of the Cavity of the Plant, in the Substance of which they lived; this seem'd to be the whole Motion for which Nature had intended them, for on the Bottom they now waded in a strange Manner, and when they rais'd themselves, they soon fell to the Bottom again. This was perform'd by Means of the hinder Part of the Body, which they apply'd to the Glass, and with a Spring from it threw themselves up; and the Intent of it seem'd evidently to seek for Filaments on which to climb, as usual.

They were, indeed, in this Situation, under a double Distress, not only deny'd the Means of their ordinary Motions, but plac'd in a Fluid vastly thinner than that in which they naturally liv'd. It was not till they became tired of the

Search after the Filaments, and languid with their repeated Efforts to rise and seek them, that they were quiet enough to be observ'd; one of them, very luckily at this Time, rested itself in the very Centre of the Fluid, and gave us a View of its Form. It was oblong and somewhat flattened in Figure, largest at the Head, and thence gradually smaller to the Tail, which was less than in almost any other Creature of this Kind, unless such as have a distinct Tail fix'd to their Bodies. The Back was somewhat elevated or convex in the Middle, the Sides very thin and pellucid; and both these and the Head and Tail were occasionally bent inward. Notwithstanding the Minuteness of this Insect, it was easy to distinguish that the Body was annulated or divided into Joints, and the Rings or Incisures made so many Notches in the Sides.

The Back, tho' much more obscure than the Sides or Tail, yet gave an Opportunity for seeing the Motions of the Intestines, which distinguish'd themselves in Form of so many greenish little Spots, and were contained from within a fourth of the Length to the Head, to very near the Extremity of the Tail.

This was all that could be distinguished in this Animacule as it lay with its Back upwards: Indeed, in the Generality of these Creatures, it is, when we get them in a contrary Direction, that we discover their several Parts and Organs. All the Motions it now gave itself, were those of occasionally inflating and contracting its Bulk, as if  
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It was done by a kind of Inspiration and Expiration, at distant Intervals; and at Times it could expand the Sides, which were usually drawn in under the Body, and by this Means render itself of twice its usual Breadth. Sometimes it would also, in the same Manner, disclose the Head, which was usually roll'd under the Body, or throw out the Tail to its whole Length from the same general Posture.

To see the lower part of the Creature, and understand the Mechanism of its Parts, we found it necessary to put the Drop of Water, in which we had these for Observation, from off the Glass, upon a Piece of thin Talc, and to cover it with another. We found, that in this bold Attempt, we had lost or destroyed two of the four Animalcules that inhabited it, but of the other two, one was at Liberty in the Fluid, and the other very luckily squeez'd toward the Edge, so as to fix it without destroying it. It was this which afforded us the Opportunity of discovering the several Parts and Structure of this singular Species: We found its whole Body hollowed or concave on the under Part, in Proportion to the Convex of the Back, and mark'd with the same annular Divisions: We found the Motions of Contraction in the Sides, were perform'd much quicker and more forcibly than we could have imagined, from what we saw in viewing the upper Part of the Creature; and it, that Way, often brought the Verges of the two opposite Sides to meet. The Tail was wound up, as it were, in a Spiral, and

the Head turn'd so inward, that little was to be distinguished of it.

We had hitherto but an unpromising Prospect of discovering the Structure of the Creature; but Patience is a Virtue, no where so useful as in natural Investigations; what it was impossible for us to have procured, offer'd itself; after a few Moments the Creature grew faint, and in its dying Agonies disclos'd its whole Form.

The Head was first unroll'd, and thrown into a Line with the Body; we saw it thus in a very plain Manner, and could distinguish a very long and large transverse Mouth, surrounded with a Kind of Bristles, which arose from each Lip, and cross'd one another: The Form in which these appeared was very singular; they stood in two Series, each plac'd in an oblique Direction pointing inward; they met at about two thirds of their Length, and there cross'd one another; so that when the Mouth was clos'd the whole had an Appearance of a kind of a Cross, form'd by two Rows of Bristles, and serving for no better Purpose than to keep any Thing from the Opening: When we saw the Mouth afterward gaping, as it frequently did while the Creature was dying, we altered our Opinion; every Motion of this Kind seperated the two Series of Hairs, far enough to let in whatever was in the Way, and the Closing of it again answer'd no less a Purpose than that of forming a triangular Cavity before the Mouth, in which every Thing that fell in its Way was retain'd by the close Position

of



of the Hairs, till the Creature had eaten it, or chose to discharge it.

Of all the Animalcules I have met with, I look upon this, in the Structure of the Mouth, to be the most singular: Many of them have the Assistance of Limbs, a Kind of Arms or of Claws, or other Apparatus of the same Kind, to seize and to convey their Prey to the Mouth: This Creature is unprovided with any Thing of this Kind, and Nature has, therefore, made the Structure of the Mouth itself, such as needs no Assistance; by the frequent Openings and Shuttings of that Part, we discovered, that this was not all which Nature had done for it in this strange Organization. The Beards were moveable at the Creature's Pleasure, and consequently could form a larger or smaller Space before the Mouth, and cross one another in different Parts of their Length: The Mouth also, we discovered, was furnish'd with a Kind of moveable Lips, which it protruded forward, tho' but to a little Distance, at Pleasure. The Mechanism and Use of the whole was obvious. The Creature lives in a Kind of gelatinous Matter or thick Fluid, which it is to feed upon: Tho' it is to eat it, however, it is not to be cram'd or choaked with it, nor to have it eternally all about its Mouth, and forcing itself down its Throat every Time that opens. The Defence, which Nature has given it against this Inconvenience, is by this strange Apparatus of a double Beard; this closes over the Mouth, and keeps a clear Space about it, the Hairs of which

it is compos'd, standing too close to let the minutest Particle force its Way between them, and additionally, even to this, the Head is generally secur'd by being drawn in under the Belly. When it is necessary to feed, the Creature needs no more than protrude its Head, and on opening its Mouth a Quantity of the gelatinous Matter naturally gets into it: On closing it again, beside that which it is then swallowing, there is an additional Portion contain'd in the triangular Cavity, form'd before the Mouth by the two Portions of the Beard. This Quantity is greater or smaller as the Creature has chosen to extend the Cavity, or contract it by the various Directions it has given to the Hairs, and the moveable Lips are protruded to receive it: These do not dart out a great Way, but if the Cavity be small, they take in a considerable Part of it; if it be larger, they take what of its Contents is next them, and the Beards are afterwards contracted upon the rest, and by their continued Motion inward, press still more and more of it to the Mouth, till they are drawn in so far that they meet the protruded Lips, and the whole, that was contained in the Cavity, is swallowed. If that have been enough for the present Occasion, the Creature remains at Rest; if not, it opens the Mouth and the whole Apparatus of the Beards again, and takes in a fresh Quantity, larger or smaller, as it finds Occasion.

No Eyes can be discerned in the Head of this Animalcule, nor, indeed, has it need of any:

Its

Its Food is every where about it, and it has no Occasion to be warn'd of that Danger, which Nature never intended it should escape from the Destroyer before mentioned.

Its Mouth was evidently form'd for feeding in the easiest Manner, on the Substance intended as its Food; and we had no Doubt but we should find the rest of its Part as happily adapted to their several Purposes. The closing in of the Sides upon the Belly had hitherto prevented our looking upon that Part of the Creature, to see what Apparatus Nature had given it for the supporting itself on the Fibres on which it spent its Life; the Agonies and Strugglings that had disclos'd the Structure of the Head to us, soon answered the same Purpose, in regard to the other Parts. The Tail first unwound that little Spiral, in which it had hitherto been involv'd, and we could distinguish, at its Extremity, a Hollow, suited to the taking fast hold of any Thing, in the Manner of that at the Tail of a Leech. All along the Edges, for two or three Joints as well as round about the Skin of this Hollow, there were plac'd several Series of Fibres, which, doubtless, were intended for the same Purpose which those about the similar Parts of other Animalcules, are; that is, the helping to fix down the Part still more firmly.

Along the Middle of the Belly, as the Sides fell back from covering it, we could also distinguish two Rows of Legs; these stood in Pairs, but they were very few in Number, not more,

at the utmost, than twelve, and those situated at Distances, Pair from Pair. They were short, and tho' they had their Origin each close to the opposite one, they separated in their natural Direction, to a great Distance, and each was forked at the Extremity,

The Sides of the Body had Tufts of Hairs or Filaments also at certain Distances, like those of the Tail, tho' not continued as they were in that Part, along the three or four extreme Joints: These were long in Motion, after the rest of the Animal was to Appearance dead; their Movement was only vibratory, and that not quick, tho' almost continual.

This was all that offered as to the Structure and Parts of this singular Insect; and from what we had seen, and what we, after these Informations, observ'd of the Creature in its State of Health and Liberty, it was palpable, that all this was calculated for the sole Point of its supporting itself upon, and moving along the Filaments of the Plant. It might have seem'd, that the Tufts of Fibres along the Sides of the Body were intended to support it by their vibratory Motion in the Body of a Fluid; but the Aukwardness of the Creature in all its Motions; and its utter Incapacity to support itself at all, plainly proved, this was neither their Intent nor any accidental Use of them.

After we had thus seen the Creature separated from its natural Place of Residence, we examin'd it in several other thin transverse Slices of the  
Plant,

Plant, such as we had at first examined; in all these, we could see it moving nimbly along the Filaments that crossed the Cavity; but the Thickness of the Medium rendered it impossible to view them distinctly: We had Recourse to the old Method of squeezing out a Part of the Pulp, and getting it with the Animals it contained, into Water, with which we more and more diluted it, till the whole was sufficiently clear and transparent: We endeavoured to get out some of the Fibres for their moving on them in this finer Fluid, but this we not could effect as we liked; we threw in at last two or three Pieces of a Hair, and these very happily answered the Purpose: They did not sink flat to the Bottom, but rising in various Directions to the Surface, gave the Creatures an Opportunity of climbing and running upon them, just as in their natural Manner: We had, by this lucky Expedient, an Opportunity of seeing all their Motions at least as well, probably better, than if we had succeeded in the Attempt of getting out some of the Filaments, on which they naturally exerted their Talents of climbing: The Hairs were of a smother Surface, and, therefore, it was more difficult, and required more of their Address to fix upon them, than if the Roughness of the others had assisted; and the little Protuberances of those Filaments might have obscur'd some of the less conspicuous Attempts, whereas all was here distinct and obvious.

Nature has given these leffer Creatures, in general, a very sharp Appetite: They feed voraciously, and cannot live at Ease many Moments, without Opportunities of it. Nothing could be more new to these Animalcules, which had been used to live immersed in the Matter of their Food, and in which the Provision of Nature had been employed in finding the Means of preventing its being continually getting down their Throats, whether they would or not, than to seek for it in vain. We saw them gape frequently, and the Contortions of their Bodies shewed their Distaste and Surprize at finding nothing but Water in their Mouths, instead of Food.

As they have no Eyes, they can only crawl along at Random, in Search of either Food or the Means of it. Of the several Individuals that were under our Inspection in the present Drop, some crept along the Bottom one Way, and some another, 'till at length one of them came in Contact with a Piece of Hair: On the Instant a new Life and Vigour seemed to possess its whole Frame. It ascended the Hair, and performed a thousand antick Tricks upon it; but all reducible to the same Source, the seeking of Food, and the Inquietude at missing of it.

The Manner in which it ascended the Hair was singular enough: Instead of climbing up by means of the fore Legs, as might have been expected, it, on the Instant of feeling the Hair, turned up its Tail to the full Extent of its Length, the Head only remaining on the Glass, and laid  
fast

fast hold of the Surface of the Hair at that Distance from the Bottom. When the Tail was fixed, it was easy to draw up the Body after it; and in an Instant, while the Tail retained its Position, the Head was advanced beyond it, and the Creature had climbed up to twice the Length of its own Body: It now began to get higher, by means of its Legs: The Tail seemed to have no more to do in the Business. The Middle of the Belly was applied to the Hair all along; and the several Pairs of Legs, which had in this Posture all received it between them, drew towards one another, and clasped it firmly. By this Means the Creature was kept in its Place, though on this unaccustomed smooth Body, not without frequently turning quite round on it; as we see our Climbers upon Ropes often do. When it at any time recovered from this, the common Motion of the Legs, Pair by Pair, advanced it still more forward. In this Manner it continued to make climbing its only Business, 'till it had advanced to about half, or somewhat more than half, the Length of the Hair.

We could then see the Head directed first to one Side, and then to the other; and the Mouth opened each Way, though still in vain. The Disappointments were always attended with Contortions of the Body, and brought on more and more laboured Efforts, on the Part of the Creature, to succeed. The two or three first Pair of Legs were now loosened from the Hair; and the Creature directed its Body, the upper Part of which

which was now at Liberty, upwards, downwards, and on both Sides, and in all Directions, in Search of Food, still opening its Mouth, and still expressing its Distress at the Disappointment. After this, still more and more of the Legs were disengaged; and the Body, still more at Liberty, was directed every Way to a farther Distance, but in vain. At length the Tail only was employed to keep the Creature in its Place, and the whole Body was turned and twisted about every Way in vain; the Mouth still gaping at every new Turn, and the Creature still wreathing its Body about, in Token of its Dissatisfaction at receiving Water in the Place of Food. It is impossible to describe the Variety of strange Postures into which this Creature threw itself, in Agonies with Hunger and Disappointment; and trying every Change of Place in hope of Success, while the very Extremity of the Tail was all that held it.

There are many of the Animalcule Tribes, which, in Defect of vegetable Food, though their usual Support, will feed on one another. We had Opportunities of seeing this tried, in regard to these wretched Animals: They sometimes, in the Midst of their most eager Searches and continued Disappointments, came in the Way of one another; but we never saw so much as an Attempt toward their seizing upon, or any way hurting each other.



The Motions continued 'till the Drop of Water, which was the Sea in whose Bounds all this was transacted, dried away, and left them and the Hairs extended on the Surface of the Glass, seemingly as lifeless as one another. It is the Fate of the Generality of Animalcules, whose Habitation is in Fluids, to perish when those Fluids are evaporated. Some of them burst, in this Case; and others shrink up to almost nothing. The Condition of these Creatures was of the latter Kind; and their Bodies were scarce discernible upon the Hairs, after the Water was intirely gone. It was perfect Accident that discovered to me, that these Creatures, after their seeming Death by the Evaporation of the Fluid, are capable of being called to Life again by the Addition of a fresh Quantity of it. Perhaps this is the Case with many others of those which do not burst, perhaps of all: And possibly to this may be owing the sudden Appearance of many Species in their full Size, in Fluids poured into Vessels, or other Cavities, where they have once been. It is singular, that in the Case of the Paste Eels, or those oblong Animalcules which are found in a Mixture of Flour and Water, boiled together, and suffered to stand 'till it be sour; that they are not to be produced at Pleasure, from any Quantity of boiled Flour and Water that we please. Many Persons have made Paste with this Intent, and kept it, even several Months, to no Purpose. It is in the Bowls and other Vessels, in which the Stationers, and others, who are continually using  
this

this Mixture, always keep a Supply of it, that they are found. If the Vessel be ever so thoroughly cleared of the old Quantity, and some fresh Paste poured into it, this shall be stocked with innumerable Creatures of that Kind in a Day or two; whereas, if another Portion of the same Matter had been put into any other Vessel, it would have afforded none.

However this may be, as to the general, the reviving of these Creatures is palpable; and it happens on the pouring over them not only their own natural Fluid, but any other. I had chanced to lay by the Plate of Glass, on which I had been observing them, without wiping it; and, two Months after, was examining some other Object in common fresh Water, on another Part of the same Plate: Some little Quantity of the Water chanced to run to the Spot where those Fragments of Hairs and the torpid Animals lay, and, while I was examining something else, I was surpris'd to see them all restored to Life. The Accession of a Fluid, though so perfectly different from their own, recovered them to Life: They instantly performed their pristine Motions, climbed the Hairs, and darted their Bodies 'about every Way, as at first, as in Search after Prey. Their Contortions seem'd more violent, perhaps, as occasioned by the double Distress of wanting Food, and being immerg'd in a Fluid of an unnatural Kind; but they performed their old Course, and continued alive, 'till the Evaporation of the Water again returned them to their State  
of

of Torpidity. We know that many of the larger Animals will remain in this State of seeming Death, from the mere Effect of Cold; and we are not to wonder, therefore, that these lesser ones lose all Signs of Life, when the Medium, in which they are formed for living and moving, is gone: Nor is there any great Wonder that Bodies, too minute to receive the common, or indeed almost any Injuries, should remain in a Condition to exert themselves again under the proper Circumstances.



ESSAY

## ESSAY XV.

*On the Form and Qualities of an Animal inhabiting the Leaves of a Water-plant.*

THE Creature, which is to afford the Subject for this Essay, is of a somewhat larger Size than those which have given Occasion to the Generality of the others; and I the more wonder, that it has not been observed by one or other of the Naturalists. I am apt to attribute this Neglect to *England's* being the only Country where it is produced: I think, if it had been common to *France*, the indefatigable *Reamur* could not have missed it.

Our Ditches are frequently covered with the Leaves of a little Plant, which the old botanical Writers have called *Frogsbit*, and the least *Water-lily*. On observing these, one cannot but remark, that their general Colour, which is a Green, is often variegated with Spots of a dusky Brown: These are always round, usually of the same Diameter, which is about that of a Tenth of an Inch; and there are sometimes five or six, sometimes only one or two on a Leaf.

I had often observed these Spots on the Leaves of some of this Plant, which spread themselves over the Surface of a little Ditch, by the Side of the Willow-walk that leads from *Westminster* to *Chelsea*. As I frequently passed along that Place  
toward

toward the End of the last Summer, I saw that the Number of these Spots, from time to time, increased; and had the Curiosity, though I scarce took them for any thing more than the Beginnings of a Decay, to carry, one Afternoon, a Handful of them home with me for Examination.

I threw them into a Vessel of Water over Night; and had so little Expectation of any thing of Consequence from them, that I did not look at them 'till the Afternoon of the next Day. These Leaves naturally float on the Surface of the Water. There are a Number of Animals, of various Kinds and Sizes, which are in some degree amphibious: They go into the Water for Food, or on other Occasions; but spend the greater Part of their Lives out of it, though in some Place where they are close to it. The Leaves of this Plant, and of others which preserve the same Situation, are a very happy Place of Abode for these Creatures. I found many of them ranging about in different Parts of the Surface of several; and what still more surpris'd me was, that I distinguished great Numbers of very minute but genuine Caterpillars feeding on the Leaves, and evidently preparing for the Production of some minute Butterfly: These, and a diminutive Animal of the Leech Kind, were the Creatures that swarmed most upon the Leaves, though there were several others that occasionally inhabited them. Of these the Caterpillars seem'd the only Species that were not, at some time, to

plunge into the Water; and I almost wondered at the Order of Nature, that destined Creatures, so easily drowned, to live on a Plant which floated on it.

When I had examined several of the different Species, that occurred on two or three Leaves immediately under my Inspection, I turned my Eye upon what was the immediate Business of the Observation, the Spots of Brown. All that I had hitherto examined was of a Size to disclose itself to the naked Eye; nor was the Assistance of a Microscope necessary to the discovering that in the Centre of each of these Spots: There was a regular Aperture of an elliptick Figure. On a closer Observation, I could generally distinguish two Prominences, one at each End of the Aperture: These were of a black Colour, which helped to distinguish them from the Brown of the Spot; but what appeared most singular in them was, that they were not stationary or fixed, but moved about at pleasure, and often disappeared. The drawing a Hair over that Part of the Leaf where they stood, would at any time occasion their disappearing; and the same Effect as constantly followed any Motion of the Water, or the least Disturbance or Shaking of the Leaf.

It was easy to infer from this, that these were not of Vegetable but of Animal Origin, and the Subject now appeared very worthy Investigation. I fixed one of the Leaves to a Piece of Cork, and, with the Point of a very fine Pair of Scissars, slit the brown Skin; which I now saw was only a  
dry

dry Membrane, covering a Cavity from one Extremity of the Aperture to the full Diameter one Way, and from the other, the other. The fine Knippers, used as a Part of the microscopical Apparatus, easily drew off the whole Membrane after this; and I had the Pleasure to discover a regular Cavity, of an elleptick Figure, reaching in Depth down to the under Membrane of the Leaf, which, in one of the Thickness of this, is something for the Habitation of a single Insect. In this Cavity there lay, rolled up, the Body of an oblong Animal, with its Head nearly in the Centre, just opposite to where the Aperture in the Middle of the Spot had been.

On turning and shaking the Leaf over a Plate of Glass, the Creature was dislodged, and lay in a proper Situation for the Assistance of the Microscope in the Observation. Though I have mentioned this as larger than the Generality of Animals described in these Essays, it is not to be understood that it was big enough to disclose its several Parts and Organs to the naked Eye: The Microscope was necessary, and, with the Apparatus of the smallest Power, shewed a very surprising and pleasing Object.

The Creature is long and slender: Its Body is cylindrick, of equal Thickness from the Head to the Tail. Its Colour is a dusky White, and the Extremity turncated. It is divided, in the Manner of the Earthworm, into a Number of Joints, and is pellucid; seeming only a Mass of soft Matter, contained in a thin and delicate Skin.

The Head is larger than any Part of the Body, and is of a brown Colour, and seemingly of a finer Texture, or covered with a harder Matter, than the rest: There are two Eyes very distinguishable in the Front of this, and just under them in the Centre a Mouth. This is surrounded with ten Claws or Arms: Eight of them are slender, and pointed at the Extremity; but the two others are thick and large, and formed into a kind of Knippers, in the Manner of the Claws of a Scorpion or Lobster. These were the Points which, in the first Observation of the Leaves, I had seen standing up, one at the Extremity or each End of the Hole; and the Use of them, and the whole Conduct and Oeconomy of the Creature now disclosed themselves with great Readiness.

The Insect, though of this diminutive Size, is evidently of the Crab Kind, and approaches particularly to the Nature of that Species which is called the *Hermit-fish*, or *Bernard the Hermit*. As in that larger Creature, so in this Animalcule the Head and Claws only are defended with a shelly Covering, and the whole Body is naked and defenceless. Nature has directed that Creature to seek out the Shell of some dead Wilk, or other Fish of a proper Form and Size, and to secure its tender Body by creeping into that artificial Armour. In this Manner it lives at the Bottom of the Water, safe from the Teeth of a thousand different Animals, that would otherwise devour it; and is able, at Pleasure, to thrust out



its Head and Claws in Search of Prey. In the same Manner this equally defenceless Creature is instructed, by Instinct, to gnaw a Hole through the upper Membrane of the thick Leaf of this Plant: And this must be done while it is young; for the Aperture is not large enough to let it out at the full Growth. When it has got into the Substance, and among the Fibres of the Leaf, it is easy for it to eat and tear its Way down, by its Weapons, to the lower Membrane. This is so tough as to restrain its Progress; and the same Instinct which dictated to it to eat so far, stops it here, as this is to be the Floor of its Habitation. As it grows larger, it eats or digs a Way at once through the pulpy Substance and the Fibres of the Leaf all round, and forms its Cell proportionably large and comfortable.

The Part of the upper Membrane of the Leaf, thus totally separated from the under, and from the Fibres which should convey Nourishment to it, naturally decays, and becomes brown: This is the Spot which discolours the Leaf; and the Hole or Aperture at its Centre, is that by which it first made its Way into the now enlarged Cell. It lies very comfortably in this Retreat, secured from Injuries of all Kinds by its Covering, and within the Influence of the Moisture of the Water, to keep its Body, which would be withered and shrunk up in a dryer Place, in proper Order. It would be a great and continual Difficulty upon it, to be reduced to go every time out to feed; and though its Prey be of the Animal Kind, Na-

ture has contrived to furnish it without this Inconvenience.

I have observed that the Creature lies in such a Position in the Cell, that its Head is just in the Centre, and its Mouth over-against the Aperture or Hole. Any thing that chanced to come in the Way of this Pitfall, and that was small enough to be let through it, would thus directly tumble into the Mouth of the Animal; but this would be too uncertain and precarious a Provision. The two large Claws or Arms are directed the opposite Ways, and stand with their Points at a small Height above the Level of the Leaf; and the other eight, which surround these, as it were, and which are very small in Comparison of them, and of a quite different Structure and Form, are placed four on one Side and four on the other of the Aperture, though not in Sight, partly from their Minuteness, and partly from their not being elevated above the Level of the Surface. With its Weapons thus prepared, the Creature lies in a State of Indolence, expecting Food; but giving itself no Trouble about it, not so much as that of looking after it.

I have observed, that the Surfaces of these Leaves are peopled with a Variety of Reptiles, particularly with great Number of a small white Leech, and with a Caterpillar of a minute Kind. These, in their several Courses along and about the Surface, naturally came in the Way of this insidious Animal: Whatever Part of the Verge of the Aperture any one of them touches,  
there

there is a Weapon ready to seize or destroy it. The two larger Claws each terminate in a forked Extremity, capable of being opened and closed at the Creature's Pleasure; and each Side of this is denticulated like a Saw, and the Points all sharp. The other eight Arms or Claws, or by whatever other Name it may be proper to call them, terminate each in a fine, single, and very sharp Point. If the Victim chance to hold its Course across the Aperture, the Creature raises its Head, and, seizing it with the Mouth, at once draws it down into its Cell, and preys on it, without farther Preparation or Ceremony. If it come near either Extremity, there is a forked Claw ready to gape to let it in; or if too large for that, yet to take sufficient Hold, never to let go without the Animal's being torn to Pieces. If it come but Sideways, within the Reach of one of the simple and smaller Arms, the Point in which that terminates is instantly struck into it, and the Wound excites a Pain, which occasions a wreathing and twisting about of the Body; one or other Turn of which probably directs it toward the one or the other Extremity, where a larger and forked Claw is ready to seize upon it.

As soon as one of these larger Claws has fastened on the Prey, whether primarily, or in consequence of such a Wound given by one of the smaller, the opposite large Claw is brought forward towards it, and seizes on some other Part of the Creature: The other eight then all direct

their Points at once toward it, and are plunged forcibly into it, making so many Wounds, any one of which might be mortal. The Creature does not seem fond of Trouble about any thing: It does not chuse to incommode itself with its Prey that is stragling, at least while it has Strength to do this violently. The Victim is held suspended upon all the Claws at once, pinched and stabbed by them all; and when it is not any longer in a Condition to resist or incommode the Creature in feeding on it, it is conveyed to the Mouth and devoured.

By the Means of a small Magnifier, fixed to a moveable Joint, and placed near the Edge of the Vessel in which these Leaves, with their several Inhabitants upon them, were kept floating on the Water, I had an Opportunity of seeing this whole Process often repeated in the Compass of an Hour, and could view the Whole without giving any Disturbance to the Animal. If it were a Leech of the minute Kind, so frequent here, that the Creature seized upon, there was great Trouble from its violently and continued Struggling: If one of the Caterpillars, the Wounds inflicted in so many Parts at once destroyed it after a few Contortions, and it submitted, without farther Struggling, to its Fate. I found that the Leech was always eaten intire: The Caterpillar, on the contrary, was not so universally pleasant to the Taste of the Devourer. The Juices of this Reptile were all that it fed on: The Skin was left, with the Head, intire; and  
Care

Care was taken to dispose of it in a proper Manner. It was impracticable, as well as offensive to the Creature, to load its Cell with all the Spoils of these Creatures on which it fed; and to leave them on the Verge of the Hole would have been, in time, to block it up, and preclude the Way to others: Not to add, that the Sight of such Destruction would perhaps have induced others, of the same Species with the Destroyed, to alter their Course. Nature never leaves the meanest and most inconsiderable of her Creatures unprovided on these Occasions. We are told of the Insect called the *Formica Leo*, that preys in something of the same Manner with this, on whatever comes within the Verge of the Pit it prepares for their Destruction; that with great Address, as well as great Labour, it throws the Remains of its Slaughter from the Tips of its Horns to a considerable Distance from the very Verge of the Den: In the same Manner this Creature takes a great deal more Pains to get well rid of the Spoils and Remains of its slaughtered Prey, than to catch them,

Whenever a Caterpillar has been the Victim, after about three Quarters of a Minute spent in sucking up its Juices, and whatever else of it the Creature thinks proper to feed upon, one constantly sees the two larger Arms raised together out of the Centre of the Hole, and the Remains of the Prey suspended on them: They are now extended to four times the Height above the Surface at which they stand in the State of watching for

for the Prey, and by a sudden Jerk the Matter they had hold of is thrown from them, with a Violence that forces it to some Distance from the Verge of the Aperture: They are then drawn back, and placed in their proper Situation for the taking whatever next comes in the Way.

As the Creature's Eyes are no way concerned in what is seized by the Claws, being within the Cavity, and at some considerable Distance under the Verge, every thing that comes in the Way, proper or improper, is seized upon. I had set my Parcel of these Leaves out at a Window, for the Benefit of a clear Light, for the Observation; and as there were many other Vessels with Food, and other Necessaries, for several other of the Insect Tribe in the same Place, I had an Opportunity of seeing, beside the usual Accidents of the Creature's feeding, many Encounters, which probably would not have happened elsewhere.

It was not long before one of these long-legged Flies, which Authors call *Tipulæ*, came, by perfect Accident, in the Way. As these Creatures naturally frequent the Waters, it settled on one of the Leaves of this Plant that was floating on the Surface of the Basin. It was one of the very minute Species of those Kinds, which we see flying about in whole Clouds in Summer-Evenings, and usually mistake for Gnats, that settled on the Leaf on this Occasion; but though of the minutest of that Genus, the Difference between it and the Animalcule inhabiting the Cell was beyond all Degrees of Comparison or Measure.

sure. This almost infinite Superiority did not, however, preserve it from an Attack: As it walked along the Surface of the Leaf, one of its Legs trod directly upon the Spot where one of the larger Claws was situated. The forked End was instantly opened, and the Leg of the more than gigantick Animal, in the Proportion, was boldly seized upon: The Fly raised itself on the Wing instantly, and was gone. I could perceive some little Struggle just at its setting off, and found it had left a Leg behind it: This was soon discovered to be no proper Food, and it was too bulky to be conveyed away, as the Spoils of the Caterpillar were. The Creature could do no more than let it drop, and pursue its Sport again.

After various Encounters with the proper Creatures for its Prey, I saw another fiercer Conflict with this very Animal that had obtained so complete a Victory over the *Tipula*. Among the Materials, which stood about the Place where these Observations were made, there were some bruised Vegetables in earthen Vessels fermenting, and in a State of affording Nourishment for the Young of the common House-fly. This had brought innumerable Companies of that Species to the Place, and among them some others of the feather-winged Kind, of those minute white Flies, which we see in Clusters about decaying Vegetables in our Hedges; one of these, by Chance, straggled to the Leaf, in which was the Citadel of the Creature that had afforded all these Observations:

vations: In walking at random over the Surface, the Leg of the Fly fell, as that of the *Tipula* had done, into the Way of one of its Claws. Tho' this Fly be vastly smaller than even that little *Tipula*, its Limbs, it appears, are more firmly connected; a little Struggle, like that in the former Case, ensued, and in Consequence, the Fly was seen walking away, not without one of its own Legs, but with one of the Creature's that had seized it draggling behind it. Whether Obstinacy had led the unequal Antagonist, in this Struggle, to keep its Hold, or whether the pointed Serratures of the Inside of the Forceps were so deeply immersed in the Leg of the Fly, that it could free itself, so it was, that it kept its Hold till the Joint, at the Origin, gave Way, and the whole Arm came off.

This unlucky Creature seemed destined a Victim to superior Force. What had, hitherto, happened to it in these unequal Engagements, I had attributed to the Situation, into which I had brought it, and was ready to excuse Nature of any Hazards of this Kind: But there are unavoidable Dangers in the Way of every the minutest, as well as the largest, Creature; there now crawled up, from the under Side of the Leaf, a small water Beetle: This was a robust, tho' diminutive, Animal, and doubtless would have been glad to have found an easy Way of getting at the other Creature, without waiting for an Attack from it: It crawled along the Surface of the Leaf in an indolent Manner, and at length, like the others,

thers,



thers, came in the Way of the Hole: One of the forked Claws instantly seized upon one of its Legs, and held firmly; but whether this, as well as in the former Case, was voluntarily or from Necessity, is not easy to say: The Beetle marched on without any Discomposure, and whether the Membrane, covering the Hole, was weakened by the former Effort, or to whatever else it was owing, the Strength of the Animal was, by no means, equal to the stopping the Course of the Beetle: The Leg refused to give Way, as the other had done; on the contrary, the Membrane itself burst, and the whole Body of the Animal was instantly dragged out, and in a Moment eaten up by the Enemy.



## ESSAY XVI.

*On the Production and Accretion of a Sea-plant.*

AMONG the great Number of natural Subjects, which an Expedition to the Island of *Sheppey*, mentioned in one of the first of these Essays, had furnished me with, one of the most singular, tho' not of the most conspicuous, was a Sea-plant of a minute Kind, which I had, at first, taken only for the Rudiments of some larger Species, but which afterwards prov'd to be a distinct and perfect one, and at that Time at its full Growth. The Naturalists have, none of them, mentioned it; nor is it a Wonder: 'Tis not to be doubted, but the most inquisitive of them must have yet overlooked, or wanted the Opportunities of seeing many of the Vegetables, as well as many Animals, which Nature has destin'd to the Bottoms of the deeper Seas; and this, even, when Accident threw it in their Way, they might, I found by Experience, very naturally suppose to be only some known one in a less perfect State.

I had employed, in that Expedition, some of the People, whose Business it is to dredge, as they call it, for Oysters upon that remarkable Bank, off the Point of the Island, at the opposite End to that where the Fortification of *Sheerness* stands; and which, from the vast Quantity of Shells with which it is covered, is called *Shellness*.

*ness.* The Instrument, they use on this Occasion, and which they express also by the Name of a Dredge, is a hollow iron Case, let down to the proper Depth, and drawn along the Bottom till it be filled with whatever that Bottom affords, before it is taken up again: Among the Variety of Things taken up at one of these Drawings, was a Stone, of the Bigness of a Man's Fist, covered with little Vegetations ramose, brittle, and of a purple Colour: These were of all Sizes, from the Height of two thirds of an Inch, for the tallest did not exceed that, down to a tenth of an Inch; yet all of the same Structure, and the same general Figure, and only differing in this, that the taller were the more ramose, the shorter the less so. It was impossible for me, at that Time, to find Opportunity for examining all the Things I had brought up with me, but this was of the Number of those which I found it easy to get other Specimens of, on sending to the same Place. I commissioned a Gentleman, who, about three Months since, went to *Fever-sham*, to get me some more of the Plant, and the People I had at that Time employed, understood me so well, from the Remains that were about this original Stone, that they sent me up a large Quantity of it; some on Stones, some on Sea-Shells, and the finest Pieces of all, on the Bottom of an earthen Mug, which had been, on some Occasion, thrown into the Water. The whole Rim of this had been broken off, so that as nothing, but the flat Bottom remain'd: It was impossible

possible to find a fitter Object, on which to investigate them: The upper Plane of this Fragment supported not so few as a hundred of these Plants. They were of all Sizes, from that of their full Growth, to the minutest Speck imaginable, some of them too small for the Eye to discover, without the Assistance of the Microscope. I kept the whole Cluster, with their general Base or Scene of Growth, in Salt Water, and occasionally took out either the whole, or separated a single Plant in another State for Inspection.

The full-grown ones shewed themselves to be of that Genus of Sea-Plants, which the old Writers, and some of the later, have call'd *Allyonium*; but which, neither the one nor the other, seem to have well understood: One of the most perfect I first singled out for Examination, and even, without the Assistance of the Microscope, could distinguish a great deal of Beauty in it. It was full two thirds of an Inch in Height, and its main Stem as thick as a small Twine: The Leaf, when it was fixed down to the Bottom of the Mug, was a flat Cake of Matter, the same with that of the rest of the Plant, of about an Eighth of an Inch in Diameter, and of some Degree of Thickness: Its Surface was unequal and spongy, and its Colour, that of a red Coral, only with an Addition of a purple Tinge, that took off considerably from its Lustre and Liveliness: From the very Centre of this little Cake or Crust, there arose a single Stem, which

which almost instantly divided into three Branches; these were flatted, and as they advanced a little in Length became again ramose; they did not stand erect, but in a somewhat declining Posture. Each of their Ramifications divided again into several others; and these sent out short lateral Shoots, so that the whole was very ramose, and resembled a small Shrub, or rather that solid brown mountain Moss, which we have on some Parts of *Hampstead-Heath*, and which spreads into a Kind of globular Tuft, of an Inch, or thereabouts, in Diameter.

All the Branches, and even the side Shoots from the Branches, on this Sea-plant, terminated obtusely. The Colour of the whole was the same purple with that of the Base, and the Surface, in the same Manner, spongy. This was all that the naked Eye could discover of it, and this was enough to excite the Curiosity of any one accustomed to Microscopes, to trace it farther. Before I applied to the Assistance of Glasses, I however thoroughly examined, so far as the naked Eye would permit, all the Plants that the Bottom of the Mug shewed besides: On tracing these from the tallest and most perfect to the minutest, all the Difference, I could discover, was, in the Degree of Growth; as they were shorter they were less, and less ramose; and in some, only the Stem or its Rudiments, in others, nothing but the very Crust shewed itself, naked, and without the least Approach toward the rest of the Plant: In all these, the most forward, as well as the most im-

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perfect, the Colour, the Substance, and the whole external Appearance was the same.

When the unassisted Eye had thus gone its utmost Length in the Investigation, I took the Bottom of the Mug out of the Water, and placing it in a good Light, adapted a single Magnifyer of small Power, and capable of taking in a large Area, fixed on a moveable Joint, in such Manner as to be able to view all Parts of it with great Ease. The first Discovery I made, was, of a Multitude of other Rudiments of young Plants, too minute to come under the immediate Cognizance of the Eye, and scattered about Places where there had before appeared none. These, tho' so minute, were all of the same Figure, not only with one another, but with the larger; they were all round flatted Cakes or Crufts of a purple Matter, perfectly analogous to that in the full-grown Plants in Structure. This Structure appeared now, under the Advantage of Glasses, in a new Light; it had to the naked Eye seemed only cavernous, and spongy in an irregular Manner, but it now shewed a Promise of something greatly more surprising.

On directing a Glass, of somewhat larger Power, to a Branch of one of the full-grown Plants, the whole disclos'd itself in a very agreeable Manner. All the Plant, I found, was of the same Form and Composition; the extream Ramifications, as well as the main Stem, were a little flatted, not perfectly cylindric; and they appeared, in this View, not spongy, but com-  
posed

posed of a Multitude of loose and distant Fibrils; the Interstices between the Extremities of which had given the Appearance of that Spunginess first observed. These Fibrils were of the brightest and most glowing Purple; they were, from their Origin to the very Extremity, all of a Thickness, and appeared truncated at the Ends: They were not regularly protruded from a Centre to the Circumference, but arose from some lower Part of the Plant, possibly in a fair Course from the very Base, tho' it would have been impossible to trace them down so far, and they were divaricated in their Way up, and expanded in a thousand Irregularities of Direction, all along bending their Points outward, and tho' one could scarce imagine how, composing together that tolerably even Surface, which formed the Contour of the Plant.

These Ramifications, as they grew every where more and more numerous from the Root or Base upward, formed the upper Part of the Plant of a much closer and more dense Texture than the lower; toward the Bottom there might be discovered large and irregular Cavities between the Extremities of the several subordinate Ramifications, and it almost appeared a Wonder how the whole hung together; but these grew smaller and smaller higher up the Plant, the Points of the Ramifications growing all the Way closer, till toward the Top they formed a Texture so close, that it was hard to distinguish any Apertures at all in it. This Difference between the upper and

lower Parts of the Plant was wholly owing to the encreasing Number of Branches on the upper Portions of it; for as these subordinate Shoots are, throughout the Plant, all of the same Thickness, it cannot be otherwise but that where there are most of them, the Texture must be closest; where fewest, the most loose and open.

The Vegetation of the Sea-plants, in general, is so extremely different from that of the Land ones, that very eminent Naturalists have doubted whether it was a Vegetation at all, or whether they deserved the Names that were usually given them. The old German Writers have included many of them in their Histories of Fossils, and declared them mere Stones; and the French have, of late, asserted, that they are only the Cases or Nidi of Animals of various Kinds, each of which builds one for itself, and each, they say, is guided by the same Instinct that directs Birds of the same Species, in whatever Country, to build their Nests of the same Materials, and in the same Form, to erect its Habitation in the same regular and exact Manner, in whatever Sea, or about whatever Shore it is placed.

These Systems, tho' the former of them has been adopted by a great Number of the Naturalists, and the latter, by one whose single Authority is more than that of a Number by *Linnaeus*, appear to be equally erroneous. I have, in the Course of these Essays, shewn, that it is not always one distinct Species of Insect that in-

habits



habits the same Plant, but that several different ones are often found in it ; and that any of these may also be found in the Cavities of Stones, or under the Laminæ of Sea Shells ; besides which, there is no doubting that they have found, and that they only use the Hollows of these Plants in common, with any others, for their Receptacles. I have also, on some other Occasions, shewn the absolute Fructifications of two or three Species, to many of the best Naturalists of this Age, and described them in these Essays. These are analogous to those of others of the imperfect Plants, as the common Ignorance has been used to term them ; and this alone, without the other collateral Proof, would have been sufficient to overthrow such a System.

The Plant now under Consideration, one of the most singular of all the marine Kinds, and carrying as little the Appearance of Vegetation as any of them, may be very fit for explaining what is the real Case with them all, and what their Manner of Growth.

We are apt to look upon it as singular, that the Sea-plants do not take in their Nourishment by means of Roots penetrating into the Bottom of the Sea, as the ordinary Plants do by Fibres directed downward into the Earth ; but it is our Inattention to the different Circumstances that creates this Surprise, not any Thing in the Nature of Bodies. We are to consider, that the Sea-plants rise in a very different Medium from those of the Land, not in Air, on

almost vacant Space, but in a Fluid, which we find is, in itself, capable of supporting and nourishing the Land-plants independently of Earth: A Sprig of Mint will grow from an Inch to two Foot in Length, and will produce its Flowers as perfectly, and in as good Time, if its End be set in Water, as if in Earth; and many other Plants thrive even best in it; some, as the Duckweed, the Stratiotes, and the like, floating on the Surface, and sending their Roots but a little Way down, never finding any Necessity of an earthly Bottom at all.

In this Situation, in which we thus see a few of the fresh Water Plants, are all the Submarines; but under Advantages vastly greater. Those have only their Roots a little Way plunged into the Water, the rest of the Plant on the Surface; but the Submarines are totally immerfed in it, and in all Parts covered with it. The Bottom of the Sea, even if the Plants were under a Necessity of acquiring their Nourishment from the Soil, is not of a Kind proper to afford it; it is, in general, especially toward the Shores, a loose Sand, washed clean of all earthly Matter, and, indeed, in a continual Agitation from the Water: It never was intended for their Support or Nourishment, nor do we ever find them bedded in it.

As only a Part of the Land-plants is destin'd for the Office of taking up Nourishment, and that is plunged into the Earth, from whence alone that Nourishment can be received; the Sea-

plants

plants are immerfed all over in a Medium, capable of affording Nourishment; and they are, properly fpeaking, all over Root, and qualified in all Parts to take it in. The Part, by which they are affixed to the Substance they grow upon, is not to be underftood as a Root: It answers, indeed, one of the two Purpofes of the Roots of the Land-plants, that of fixing and retaining the Body in its Place; but it has nothing to do with the other, that of conveying Nourishment to it: Accordingly we find them fixed indifcriminately to all folid Bodies, that are immerfed in the Sea-water, and the Plants rifing to as much Perfection from a broken Mug or a Glafs Bottle, as from any other Foundation.

Wherever the Seed of the Parent-plant falls, it forms this Bafe; and wherever the Bafe fixes itfelf, the Plant is fure to rife. On examining this peculiar Vegetable, the Obfervation of which has led to thefe general Reflections, I found the whole Surface equally and uniformly prepared for receiving Nourishment, and formed, in reality, more like the Root, than the fupraterrene Part of the Land-plants. The Bafe, as well as the Stems, the Shoots, and the fmalleft Ramifications, were all compofed of Fibrils, tending to the Circumference, and there terminating in truncated Ends; and thofe not closed, but all having an Opening very perceptible to the Microfcope. Every Fibre of the Plant, in this Manner, answered to every Filament of the Root in the Land-plants; and inftead of their being any Neceffity

cessity of a Supply of Nourishment to be sent up into the Body of the Vegetable from the Base, the only Substance, in every the minutest Part, absorbed the Fluid that was in immediate Contact with every Part of it, and sent it down to the Base, the only Business of which was to fix and retain the whole in its Place. On the strictest Examination of the Plant, this appeared to be exactly and truly the Course of Nature. The flat Cake, which served as the Support of the Whole, was inconsiderable at first; but as the Plant grew, that is, as more and more of these Mouths were opened for receiving Nourishment, the Crust or Base increased in Size; and thus was rendered of more Force, to hold it, as it grew larger, and required a better Support.

The Manner of the Accretion of the Sea-plants, was sufficiently evident from this; but there yet remained an Attempt to discover the Means of their immediate Propagation: This was an Investigation in which I had succeeded, in regard to another of the Submarine Kingdom, as mentioned to have afforded such an Elucidation; and the Success of that Attempt encouraged me to pursue the same Road in this. Beside the extreme Minuteness of the Fructifications in these Plants, and the hidden Manner in which they must necessarily be arranged, to prevent the continual Injuries they would otherwise be subject to from the Motions of the Water, there was a farther Discouragement in the Uncertainty

certainty as to the Time of Year in which they appear. The Man who was to examine the Ground-ivy in Autumn, or the Briony in Spring, though he did it ever so carefully, would find no Marks or Appearances of the Fructification, tho' the Plants appeared very fair and perfect: And, in the same Manner, he who dissects and investigates, with ever so great Accuracy, one of the Sea-plants, at a Time of the Year distant from that in which the Fructifications appear, may conclude it produces none, though they are in their Season ever so fair. It is from this, I am apt to believe, that many have so roundly asserted the Absence of all the Parts of Fructification in Sea-plants, in which I have since discovered them: Nor have the Authors of those too free Assertions considered, what Injury they were doing to the Science. Of the Writers on these Subjects, nine out of ten are wholly unacquainted with the Bodies themselves: They are fond of positive Declarations, as carrying the Appearance of Knowledge: They take upon Credit, from one another, all that they meet with of these; and People, who are disposed to investigate the Subject afterwards, find, on a Review of the Evidence, such a Cloud of Witnesses against what they would hope to be the Truth, that they give up their Intentions, which might have been carried into Perfection; not considering, not distinguishing perhaps, that what they are receiving as the Testimony of ten People, is but the real Evidence of one; and that, ten to

one,

one, founded on an original Mistake, or on some Accident in the Method, or in the Time of the Examination.

Had not I looked upon the general Assertions, even of acknowledged good Authors, in this Light, I had never so much as attempted to discover the Fructifications of the Coralline, or of the round Alcyonium before described. The Sea-plants had passed with me, upon the Assertions of the great *Jussieu*, and the greater *Linnaeus*, as the Fabricature of Insects; and I had not even had a Thought of seeking after any farther Notices of a Vegetable in the Plant, which is the immediate Subject of this Essay.

The Success I had met with, in the Investigations of the others, led me to examine some of the most perfect of these Plants at different times, with all the Variety of the microscopic Apparatus, with single Glasses, with the combined Powers of the double Microscope, with those in each of smaller Power and clearer Light, and of greater, under the Disadvantages of more Obscurity. I had examined the Plant intire, and in Pieces cut from different Parts; in Water, and in the open Air, and all to no Purpose. I would rather have concluded from this, that the Plant produced its Fructifications at some different Time of the Year, than that it did not produce any, had I gone no farther in the Search; but there yet remained something to be tried. The Apertures at the Extremities of all the Branches convinced me, that they were hollow  
all

all the Way; and the Care taken, in the Oeconomy of many other of the Sea-plants, to preserve the Parts of Fructification from Injury, by concealing them within the Body of the Plant, led me to suspect, that they might probably enough be in this contained within the Branches themselves.

On cutting the whole Plant transversely in many Places at once, and examining the new Openings made in the Ramifications, I could often discover a kind of round Globules hanging about them: And in repeating the Operation on a more flourishing and riper Plant, the whole Surface of the Plate of Glass, on which I was making the Observation, so far as it was covered by the Water in which the Fragments of the Plant lay, was also covered in an Instant with these Globules, which made their way, in greater or smaller Quantities, out of almost all the Apertures, and out of those of some of the upper Ramifications, in inconceivable Quantities.

That these regular Bodies were either the Farinæ, or the Seeds, or the Antheræ, containing the one, or the Capsules holding the other, was evident; but which of all these they were, remained yet to be determined. I hardly remember the having undertaken a more difficult Task than that of opening a Branch, in such a way as to shew this. It was necessary, in order to the seeing these Parts, whatever they were, in their natural Situation, to open one of the Branches in a longitudinal Direction, and that in  
so

ſo gentle a Manner as not to diſturb them. After the thouſand Miſcarriages naturally attending ſuch an Attempt as this, the ſingle Ramification, which I had ſucceeded in the opening, had none in it. Whether it was too young to have produced any, or too old to have retained them; whether there ever had been any in it at all, or whatever thoſe were that had been diſlodged by the Motions given it in the Operation; nothing appeared but a ſmooth Surface.

The Naturaliſt is not to be diſcouraged, even when his moſt laboured Attempts do not at the firſt ſucceed. The Way by which this had been opened ſucceſsfully, directed to the opening more in the ſame Manner. That which appears impracticable in the Infancy of an Attempt, is familiar after the firſt Succeſs. I now ſucceeded, with tolerable Facility, in ſlitting ſeveral even of the fineſt Ramifications; and out of a Number, that were at once expoſed to the Focus of the double Microſcope, found three or four in a Condition to answer all my Expectations. This, however, tho' it magnified to a great Degree, and ſhewed plainly enough that there were Fructifications on the inner Surface of the Branch, was by no means the Apparatus with which to ſee them diſtinctly. It was eaſy to ſee by it which was the beſt furniſhed Segment, and I took up this carefully in the Forceps of the Apparatus for viewing opaque Objects.

This was a happy Piece for the Investigation: It was the Half of a Ramification, from its very  
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Extremity to a first Volution or Turn, as they have several in their whole Course. The upper Part, toward the Extremity, was quite bare: The lower Half, or nearly so much, was furnished in a most elegant Manner with distinct Male and Female Fructifications. The Female ones were the same with those Globules which had been discharged in the cutting of the former Branches, and were sufficiently conspicuous: The Male were, on the other hand, extremely minute; and, with any thing less than a very powerful Magnifier, might have escaped Observation, even where the others were seen ever so distinctly.

The Male and Female Parts of the Fructification were arranged in a very singular Manner in this Plant: They stood above one another, but that not as in many Plants, where the Male Flowers occupy all the upper Part, and the Female all the under: In this they stood in Circles over one another, throughout all that Part of the Branch which they occupied. In the Subject of this particular Observation they were but Semi-circles; but as this was only a longitudinal Section of a Cylinder, there was no room to doubt of the opposite Half being filled in the same Manner. Tho' the Arrangement began but from the Middle of this Segment, itself a very short one, there were no less than eleven Series of the Flowers of each Kind, in all twenty-two. The uppermost Series consisted of inconceivably small Tufts, of oblong and slender Bodies: The  
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second, or that immediately under it, of round ones, greatly superior in Size: The third of the tufted and oblong; the fourth of the simple and round; and so on to the lowest. The tufted and minute ones were Antheræ, loaded with Farina Fecundans: The others, or larger and simple round ones, were Seed-vessels, each pierced with three Apertures, very distinguishable in the upper Part, and filled with Seeds. The Antheræ, in their natural Situation, hang down upon the Capsules, or Seed-vessels; so that it is impossible for them to burst, without impregnating them. But there yet appeared a Difficulty about the discharging of these Seed-vessels, or their Contents, in order to the Production of the future Plants. The Branches of the Plant, if not erect, all run in a Direction, pointing upwards. The Cavity within the Branch is very small; and the Mouth or Opening being at a considerable Distance above the Place of the Seeds, it was difficult, if not impossible, to conceive how they should be discharged at it.

This was a Difficulty that perplexed me a great while. In endeavouring to solve it, I had been at the Pains of dissecting Multitudes of other Ramifications of the same Plant; and in all these I found a perfect Similarity, in a respect in which I had not at all expected it. I observed, in speaking of the first Branch, that it was an extreme Ramification, slit down to the first Turning or Convolution, of which there are several in the Plant. In all my succeeding Investigations I

found that these extreme Ramifications, or extreme Joints of the Ramifications, if I may so call them, and only these, contained the Fructifications. The lower Parts of the same Branches had larger Cavities; but tho' these extreme ones always abounded in their lower half with Fructifications, the others never had the least Vestige of any, either of the Male or Female Kind. This had appeared singular to me at first; but it struck me extremely afterwards to find, that Nature had made a Provision for the Propagation of the Plant by this Means, which could not have been executed by any other. When the Seeds are ripe in these extreme Ramifications, they all break off of themselves, at the End or Convolution, and fall to the Bottom. Their Globules, or Fruits, containing the Seeds, then make their Way out of them, as they had done out of the Segments of them, in the first Experiment that promised Success before the double Microscope; and as many of these as escape the being washed off the Place, burst in a little time, and discharge their Seeds: Many of which, as is the Case in all the minute Vegetables, come to nothing; but a sufficient Number succeed to produce new Plants, for the Continuation of the Species.

When I had thus far entered into the Secrets of Nature's Oeconomy, which, to understand, is always to admire; I prepared for a more nice Scrutiny into the Nature of each of the Parts of the Fructification, the general Use and Manner  
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of Operation of which had now been sufficiently explained. There is no pursuing any Microscopic Enquiry to the Purpose, without a Variety of Apparatus at hand, ready to every Change, whether accidental or natural in the Object; and to the different Intent of the several Parts of the Investigation. I had removed the Object from before the double Microscope, in order to have a distinct View of the several Parts in their natural Situation, but to enquire into the exact Form, Structure, and Contents of each. It became necessary, to have Recourse to that Instrument again: A single Glass, of sufficient Power, was the most proper for seeing the Situation and Arrangement of the several Parts, in regard to one another; but when each became the Object of Investigation singly, a greater Power became necessary than could be expected in a single Lens, and the Object would be more happily viewed on a transparent Plane laid under it, than in the opaque one directly opposite.

Having made a thin Plate of fine Glass, perfectly clean, we continued, with great Caution, to get a Quantity of the Contents of one of our Segments of an extreme Ramification upon it, loose from the Body, in which they were before enclosed. This new Object was obtained, not without considerable Difficulty, by means of a fine Camel's-hair Pencil, from the Cavities of several of the opened Branches. On directing the Apparatus towards it, we saw very distinctly the Male and Female Parts of the Fructification:

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The Female, from their Size and Figure, were unhurt by the Operation that had dislodged them, but the more tender Structure of the Male had exposed them to so much Danger, that few of them were entire. Before we proceeded farther in the Examination of these, we took up one of the Segments of the Branches, from which they had been dislodged; by the Pencil, and examining its Surface, we found a Number of regular hemispheric Cavities, out of each of which one of the Fruits had been dislodged, and in the intermediate Series, many short and very slender Pedicles, which had served to support the Antheræ.

The Capsules, we found by this, had left no Part of their Apparatus behind them, and we were, therefore, sure of seeing them perfect; but it was plainly otherwise with the Antheræ. When, after this Examination of the Place of their Attachments, we turned our Eyes to the other Microscope, and viewed the Bodies themselves; we found as must have been expected, the Capsules entire round, of a pale yellowish Colour, and perfectly smooth and glossy on the Surface, unless where the three Apertures appeared: These were regularly situated in all: They were on that Part of the Capsula that was uppermost in its natural Situation, while growing in the Plant, and were disposed in a triangular Figure; each was of an oval Form, and the Depression, which appeared at first to be the naked, an absolute Aperture, considerably large; but the real Aperture,

ture, which was in the Centre of it, extremely minute.

The Male Fructifications, or Antheræ, appeared, in general, loose and distinct; they were wiped off their Pedicles, as we had seen, by finding those Pedicles, or Stamina to use the Botanical Term, remaining on the Surface of the Ramification. But tho' this was the Case in most, it was not so in all. We had some entire, the Pedicle or Stamen, taken off clean from the Surface: These appeared tufted, as in their original Situation, and let us into the genuine Structure of the whole. On examining one of these perfect Male Fructifications, we found the Stamen very short, simple, and of a cylindric Figure. At its Top stood no smaller a Number than eighteen Antheræ, each supported on an inconceivably minute Pedicle of its own: These formed the Tuft we had at first seen in the natural Situation in the Plant; and of these there were now a sufficient Quantity, loose on all Parts of the Surface of the Glass, to give an Opportunity to examine their Form.

Each Anthera was of an oblong Figure, obtuse at each End, and furrowed down the Middle; its whole Surface, beside, appeared granulated; and in some of the riper ones, we could distinguish a Kind of Opening in the Depth of the Furrow, at that End which was farthest from the Pedicle. This was all that appeared, on the Examination of them, on the dry Surface of the Glass; but there remained a Trial, under which,  
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much more was to be expected. It is the Nature of many of the Antheræ, even of the Land-plants, as well as of the Farina of almost all, to burst on the being immerfed in Water: There was much greater Reason to expect such a Change in these Globules, taken from a Plant, whose constant Residence is under Water, and whose Propagation must be carried on in that Medium.

We poured a Drop of Water on the Part of the Plate of Glass, on which the Objects lay; and even, before we could direct our Eyes to the Microscope, a strange Change was made: On looking upon the Drop of Water, thus let loose upon the Globules, all was in a State of Confusion, no part of the Fluid was at rest; but Streams of a fine subtile Matter were diffusing themselves every Way, and from all Parts at once. This Sort of Confusion very frequently attends the viewing too large a Quantity of the Object at once; and that was the whole Source of it here. The dry State, in which these Bodies had lain for some Minutes, and which is quite unnatural to them, had so altered their Texture, that they were all bursting at once, on the fresh Application of Water. On tracing the spreading of the Drop at one Side, we had an Opportunity of seeing the Process with more Regularity. There lay in the Way of this spreading Stream two or three loose Antheræ, and as many of the Capsules. On its reaching the first of the Capsules, which was the nearest Object, the Body burst, at the Instant of the Contact, in an irregular Man-

ner, and threw out a great Quantity of Seeds. These were of a cordated or heartlike Shape, and flat, and their Colour a pale whitish brown. Their Thinness, as well as Minuteness, one would have imagined would have carried them on the Instant to the Surface; but instead of this, they all sunk precipitately to the Bottom; and before they had been there half a Minute, we could see each surrounded with a Cake of Jelly, fixing it down to the Plane of Glass.

This is easily conceived, in Consequence of what we know, in regard to some of the Seeds of the larger Plants; but the Use of it is no where so obvious as in this. There are many of the larger Seeds, which have a Quality of rendering Water mucilaginous: These, on dropping a single Seed into the Water, or holding it in the Mouth but a Moment, when examined afterwards, are found surrounded with a fine Mass of Jelly; that is, they have retained a little of the Fluid about their Surface, and have converted that minute Portion, on the Instant, into a Jelly.

This may be of Use to some of the lighter Seeds of larger Plants, in fixing them immediately to the Earth, by means of the Dews, till they strike Root, and are safe from being blown away by the Winds; but in the Sea-plants, it is more obviously necessary: In these, it serves to fasten them to the Stone, the Shell or whatever other solid Body they fall upon; and without it, they



they must be instantly washed off by the Motion of the Water.

While we were examining these Seeds, and the Manner of their being retained in their Place, the Drop spread itself to one of the Antheræ. By that Time this was half covered, it burst open with great Violence, and all the Fluid was absorbed by the fine Matter, which made its Way from it in Form of Smoak.

When all was quiet again, we could see that the Antheræ had burst regularly along the Furrow in its Middle; but tho' the magnifying Power, now used, was sufficient to see the Mass of Powder discharged from this Fissure, as it diffused itself in Water, in Form of Smoak, it was not enough to distinguish the separate Particles: When the Liquor cleared up again, it appeared as if, whatever rendered it obscure, was melted away in it, for there was nothing to be distinguished but the burst Anthera, and some of the Seeds that had spread themselves so far.

On adapting a larger magnifying Power, we distinguished, that all the Matter remained in its own Form, tho' the Particles of it were too minute for the Apparatus, which had shewn the Seeds: We now saw the whole Surface of the Glass to some Distance about the Antheræ, spread over with little round Bodies, almost contiguous to one another: These were the Granules, which had been discharged by the Antheræ; and while our Eyes were upon them, we could see Multitudes of them bursting again in their Turn, and

throwing out their minute Portions of an inconceivably fine Matter.

The whole of the Fructification had now been distinctly seen, and appeared not only analogous to that of many other of the Sea-plants, as well as of those called the less perfect of the Land ones, but contrived and conducted in such a Manner, that it is impossible it should fail of succeeding against all Disadvantages, and creating a Wonder, that the whole Surface of the Bottom is not over-run with this single Species. We are not to suppose, that every one of the Seeds of this Plant, which is washed off from the Stone or Shell, on which it falls, is lost: The same Motion of the Water that washed it off from one, will wash it on another, where it will equally stick, and as easily produce its Species. The most probable Conjecture, to account for the small Number of these Plants that are produced, in Proportion to the Number of Seeds dropped by each, is, that those Seeds are the Food of Animalcules of one Kind or other, Millions of which are found on every thing in the Sea; and that 'tis thus they are supplied with Food, and the abundant Increase of the single Species of Plant prevented.

What is most singular in the Fructification and Propagation of this Plant, is, the dropping off of the Ramifications at the Joint, just below where the Seeds lie: This, so far as I know, is peculiar to this single Plant, and is a Provision, at once, useful in the most eminent Degree, and surprising

surprising. I am to add, that the Insects, without the Substance of the Plant, are not the only Devourers of its abundant Produce of Seeds: The Dissections of the various Parts of the Ramifications afforded very early Proofs of its Cavities not being uninhabited. Insects, of a sufficiently singular Appearance, disclosed themselves in the opening those Retreats. But, not to confuse the Account, I have stuck intirely to the botanical Discoveries in this Essay, and reserved the Examination of the Animal Inhabitants for the succeeding.



## E S S A Y XVII.

*On the Form and Structure of an Animalcule inhabiting the Sea-plant described in the preceding Essay.*

**I**N many of the Submarine Plants, which have been the Subjects of the preceding Essays, it has been impossible to miss of seeing the Animalcules which inhabited them, under one or other Situation disclosing themselves from some Part of the Plant. In the Vegetable which has afforded the Subject for the last Essay, it is otherwise. I am apt to believe, that all the Sea-plants which have Cavities naturally in them, have those Cavities generally inhabited by one or other of the Animalcules of the Sea; and that, as all the little Hollows we see about Stones and Shells are subject to the same Fate, these have it in a superior Degree, as they are better fitted for it, as they are more regular, and afford better Security to the Creatures. The Species last described is one of those that have sufficient natural Hollows, and they are always sufficiently peopled with Inhabitants; but as the Generality of these Creatures find only a soft Lodging and Covert within the Plant, and are forced to hunt for their Food without, and are consequently to be seen on many Occasions, Nature has, on the contrary, provided Food for this Creature within, and given

given it Lodgment and Support in the same Place : It is therefore under no Necessity of protruding any Part of its Form out of the Cell ; nor indeed does it appear, so far as I have observed, at all voluntarily under any Circumstances.

The repeated Opportunities I had found of seeing the Animal Inhabitants of the Corallines, and other Plants, thrust themselves out of their appropriated Cavities, and vibrate their Arms or other Limbs about, in the Expanse of the Fluid, in Search of Food, made me watch this Plant very narrowly, in Expectation of seeing some such Appearance, from the open Extremities of its Ramifications. I had found my Expectations frustrated in this, and had begun to look upon it as a Singularity in the Oeconomy of Nature, that such a Number of Cells, very well calculated for the Abode of these minute Creatures, should be destitute of them ; when the cutting open the Branches, in Search of the Fructifications, discovered not those only, but what I had very little expected, Animalcules as numerous as they are in most of the other Sea-plants, and of a Kind wholly different from those found in them all.

Most of the Animalcule Kinds are carnivorous, if the Expression may be allowed ; or are Creatures of Prey, feeding indiscriminately on all that are of a smaller Size than themselves. This singular Creature, on the contrary, is truly of the Nature of those Animals that feed on Vegetables ; and the Fruits of the Plant, whose Cavities it inhabits, are its Prey. I had doubted whether  
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the Hollows in the Fibres, which constitute that singular Plant, were continued or interrupted; but the Progress of this Creature seems to shew, that they are continued: And, indeed, its Course has done more toward letting me into the true Structure of the Plant, in this Particular, than all that my closest Investigations otherwise could. When I had made myself acquainted with its Form, I could trace its Entrance into the Plant; and have often wondered how it happened, that I did not first discover the Creature on the Matter on which it grew, where it is in sufficient Plenty; though its Minuteness had perfectly screened it from me there, till it had been seen in the Hollows of the Branches.

I have observed, that this Vegetable consists of a Base, or flat and expanded Crust, from the Centre of which the Stem arises. This Crust, as well as the Stem and the Branches, is composed of Fibrills, directed in a tortuous Manner, obliquely upwards, and all open at the Ends. Tho' my closest Examination, before I had discovered these Animalcules in a Section of the Plant, could never see one, or any Part of one, thrusting out its Head at the Apertures of the Body or Branches; yet, when I had once seen it, I could almost at any time distinguish several on the Crust, tho' never on any other Part, crawling up the Fibrills; and tho' not protruding their Heads out of, yet thrusting them into the Apertures.

It would not be easy for a young Investigator of these Subjects, even when let thus far into the History of the Creature, to understand its drawing itself in, or its thrusting its Head out of the Extremities of these Fibrils; but that is owing to a Singularity in the Structure of the Creature, which will be explained in its Description, its hinder Part being furnished with a more conspicuous Apparatus than its anterior. All that is to be said in this Place is, that as the Creature's Food, and principal Habitation, is in the extreme Ramifications of the Top of the Plant, and its Place of Entrance at the very Bottom; that the Cavities are evidently continued throughout; and that, as it enters at the Surface of the Crust, there must be a Communication also between that and the Body of the Plant.

The Animalcules, as they wandered about the Surface of the Bottom of the Vessel, on which the several Plants of this Species grew, seemed in Search only of some of them. The Instant they came in Contact with a Crust of any one, they ascended the first Ramification that came in their Way, and, as soon as they had got at its Summit, plunged themselves into its Cavity, and were no more seen. I never saw one of these Creatures making its Way out of the Plant, at any Part, nor ever once saw one of them entering any where, but at the Base. This may be easily enough accounted for, by that being the first Part they must arrive at, and by their Eagerness to get into the first Cavity that offers; but

as they are found in all Parts of the Plant, and enter only at this, it is plain, that there must be a Communication between these which seem the separate Fibrils of the Crust, and those of the Body of the Vegetable.

Having understood thus much of the Manners and Oeconomy of this Creature, it may be time to speak of its Form. In the very first Operation of cutting the Ramifications across, beside the Fruits which made their Way out of the separated Segments, many of these Animalcules were also turned adrift by the same violent Means, that would otherwise have remained there as long as the Fruits themselves. In the subsequent longitudinal Sections of some of the extreme Branches, I had also an Opportunity of seeing them alive, and feeding. Before I could well understand the Manner of their doing this, it was necessary to examine their Form. Some of those which had accidentally discharged themselves at the transverse Sections, might have served for this Examination; but the Number of those swept out, together with the Fruits and Antheræ from one of the longitudinal ones, gave more Variety and Choice. We selected a Drop of the clearest Part of the Water, in which there were several of these, procured by a subsequent Operation of that Kind; and, adapting a proper Apparatus, the double Microscope gave us a fine View of them. They were in Motion, and seemed uneasy at having been forced out of their Habitation: We singled out one of the fairest,



fairest, and, confining our Observations to that, had an Opportunity, under its various Contortions and Convolutions, to see its whole Manner of moving, as well as perfectly to understand its Form. It was of an oblong Figure, smallest at the Head, and all the Way larger to the opposite Extremity. The general Colour was a pale pearley Blue; but the Body was divided into a great Number of Rings, in the Manner of the Generality of the Insect Kind; and the annular Cordages, for such they seemed which divided the Rings, were of a high and elegant Scarlet. This gave a glaring and beautiful Variegation to the Body; nor was this all the Beauty that the assisted Eye discovered in it: The Head was terminated by a Weapon of the Figure of a Reaper's Sickle, hooked, sharp-pointed, thick and even at the Back, and ferrated on the anterior or inner Edge, and throughout of a deep, glossy, black Colour, and a horney Appearance. From the truncated Extremity there issued, as it appeared at first Sight, a large conic Body of the same Colour with the Cartilages of the Body; but as this was afterwards expanded, we discovered it to be no more than a Tuft of Hairs, consisting of an almost innumerable Multitude, and those of a very pale flesh Colour when separated, tho' they appeared of that high Scarlet while in the Cluster.

It was not so easy to get a View of the Belly, or under Part of the Animal, as of the Back; but, after some fruitless Attempts, we succeeded.

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We found, that immediately under the Base of the Sickle-like Weapon at the Head, there opened a large transverse Mouth, both Jaws of which were moveable; and that the whole Surface of the Belly was rough like a File, or covered with short pointed Eminences, the Points of them all directed backwards. We were at the Pains of adapting a larger magnifying Power immediately after this, to examine whether the Surface of the Back were not covered with the same kind of pointed Eminences; but we found, that, on the strictest Examination, it was perfectly smooth. Having seen thus much of the Form and Structure of the Animal, we were in a Condition to understand its Manner of feeding; and not only this, but its very Motion along the Cavity of the Plant afforded something very singular in the Observation.

As the Body of this Animalcule bears no Proportion to the Diameter of the Cavity, small as that is, in the Ramification of the Plant, we soon found that the pointed Protuberances of the Belly were very necessary, but that the same Apparatus on the Back could have been of no Service. As the Motion of the Creature is intended to be almost continually upwards, it requires some Apparatus to climb; and not only that, but some Contrivance to keep it firm in a declining Tube, while it is eating. Had its Body been large enough to come all round, in Contact with the Sides of that Cavity, a Series of Points all round it, like those of the Belly, would very happily

happily have prevented its slipping down ; but as that was not the Case, Nature has made a Provision for its Safety in that singular Brush of Hairs at its Tail. The Manner of its moving is this: It protrudes the Head to its utmost Length, and strikes the sharp Point of the Weapon, by which it is terminated, into the Side of the Cavity: This holds sufficiently fast, and it draws up the whole Body after it. The Points of the Belly then preserve it from slipping down again, while it repeats the Elongation of the Head, and the fixing of the Point, 'till the drawing up of the Body again. This sufficiently serves the Purpose of its moving; but that is not all that is required: It is to feed as well as to change Place; and in feeding it would be liable to slip down continually, thro' the Motions of Deglutition, and Elevations of at least the anterior Part of the Body, if there were not some farther Provision. We had observed the continued Motion up the Side of one of the longitudinal Sections of the Ramifications, in which we had three or four of them now in View at once, before the single Magnifier of the Microscope for opake Objects; and it was continued with great Ease and Composure. When we had fully examined the Form and Structure of the Creature, before the double Microscope, we had made this Change in the Apparatus, for the sake of seeing the Use it made of its several Parts, as well in its Motions as in feeding; and we succeeded very happily.

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The continued Course of one of them, which we had rendered more difficult than it is in Nature, by placing the Ramification in a perpendicular instead of an oblique Direction, at length led it to the Place where the several Series of the Fructifications grew. As its Motion was from below, and the Series of Fruits is always placed under that of the Antheræ, it first came in Contact with one of these. We now saw that the sharp Instrument at the Head had a farther Use, beside that of assisting it in its Motion: It raised and drew back the whole anterior Part of the Body; and in striking it forward again, plunged the Instrument deep into the Body of one of the Fruits. In an Instant we saw the Creature draw back its Head again: This Motion pulled downwards the Instrument now immersed in the Body of the Capsula, and cut it quite thro'; and the Seeds burst out in vast Quantities at the Wound, and the Creature prepared to feed on them.

The first Requisite toward this, was the keeping its Body firmly in its Place, without danger of its slipping down, and thus losing the Food. We could see this but imperfectly done, as the Creature was not now in a whole Tube, but only in a Segment of one: The Means however were evident. The Pencil of Hairs at the Tail was expanded to such a Diameter as would have totally filled up the Cavity, and rendered it impossible for any Force, less than what would destroy its Form, to carry it downward out of its Place.

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The Creature perceived the Want of the other half of the Tube, it expanded the Hairs to their utmost, and kept them in a strait Position some time; at length, as if despairing of what it hoped to find, it applied its Belly very closely to the Surface, and fed probably more slowly, but in as much Security, as if the Tube had been entire, and the Pencil at the Tail in full Force for the preserving it.

The Instrument at the Head was of no Use at all in the feeding, the Mouth received the Seeds as they rolled down upon it, and either swallowed them whole, or itself ground them to Pieces; for the Weapon, that had torn open the Capsule, was never employed to break them: When they were all eaten or had slipped down, for many did so while the Creature made no Attempts to recover them, it began its Motions upright again, never turning its Head to either Side, tho' both on the right and left there were more of the Fruits. It continued its Course thro' the tufted Clusters of the Antheræ, which were placed over this Series of the Fruit, without meddling with any of them; but as soon as it arrived at the next Series of Fruit, it tore open the first that came into its Way and fed on its Contents in the same Manner as on those of the former.

## ESSAY XVIII.

*On the Structure and Fruëctification of a minute Plant.*

**T**HE last Year has afforded Pomegranates in greater Perfection than they have been known. They are a Fruit that keep a long Time, and become mellow after they have been taken from the Tree ; but, in order to their preserving themselves in Perfection, it is necessary that the hard, and almost woody Shell, which Nature has given them, be preserved entire : On opening several of the finest I have seen, we accidentally met with one that, from some Accident in the Carriage, had got a Depression or Dent in the Shell toward the upper Part, and a Crack open a little Way across the Middle of the Depression. This was the only one that shewed any Sign of Decay.

The Air is the great Source of Destruction to Bodies, whether of the Animal or Vegetable Kingdoms : but 'tis not always that we understand, by what Means or in what Manner, that is performed. What we term Destruction and Decay of one Thing, is often the Production and ripening of a Multitude of others : This was the Case in the present Accident, and what we accused as the Decay of a single Fruit, was the Accretion or Perfection of a Multitude of ele-

elegant Plants. Wherever the Air is admitted, a thousand different Things find their Way with it, and that which we attribute to the Effects of that Fluid, is, in general, to be given to the Multitudes of Bodies which it is fraught with, and to a Multitude of others that make their Way in with it. *Redi* observed, that Flesh, preserved from the Access of Flies, would breed no Maggots; and 'tis as constant an Observation, that vegetable Substances will keep a long Time, in whatever State they are, if the Air be shut out; but, that as soon as it is admitted, they also produce or afford their several Kinds, whether of animal or of minuter vegetable Inhabitants. In the first of these Cases, the Parent-flies make their Way to the exposed Flesh, and deposite their Eggs, for the Produce of a new Offspring: In the other, Multitudes of the Seeds of minute Plants, and Ovula of Animals, are floating in the Air, and getting in wherever it does; they find the Place proper for Vegetation and Accretion, and they burst their Enclosures, and attain their Growth as regularly as the Seeds of Plants deposited in the Earth, or the Eggs of the larger Animals in the Nest.

Thus much may serve, in general, as an Explication of the Appearance of minute Animals, and as minute vegetable Bodies so frequently, indeed, so universally, seen on and in decaying Substances: And the present Instance adds its Part to the Elucidation. I have observed, that of all the Pomegranates, which had the outer

Shell entire, the inner pulpy Mater was also in Perfection: In this only one, which had a Crack, and that so minute a one, that it was scarce perceptible to the Eye, the Part of Fruit nearest that Fissure was in a State of Decay: The Surface of the Pulp, as well as the Seeds, was mouldy.

What would have been thrown away on another Occasion, as the Company where the Fruit was cut, were all of an inquisitive Turn, was preserved as the most valuable Part of it: We do not attend to it in general, but what we call Mouldiness must be something not mere Foulness or excrementitious Matter. The curious People of the last Age or two have shewed, that what is thus called in general, is a Plant; but this singular Instance, as it was on a Subject not examined before on such an Occasion, so it afforded a Species of Plant, infinitely more elegant than any that has been described.

We have been used, tho' with no Sort of Propriety, to call all the minute Vegetables, produced in this Manner, by the Name of Fungus's. This is a Plant wholly different, in its Form and Structure, from all those usually known by that Name; and is, indeed, a Vegetable *sui generis*, of a Kind different from all that have been described. It is strange, that we should meet with this no where, but on this singular Occasion; the Seeds of it must undoubtedly be floating about in the Air; they must be minute enough to enter with it at that Crack; and it is  
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very singular, that, among the Multiplicity and in the Variety of Bodies on which they must fall, only the decaying State of this foreign Fruit should afford a Substance, on which they could shoot and arrive at Perfection.

The whole Surface of the pulpy Matter, under the Depression and all about the same Part, was covered with what appeared to the unassisted Eye, a Quantity of loose Filaments of a bluish white Colour, and of a soft and tender Structure. Their very Surface did not seem even or continuous, but irregular or cavernous; and their Points were inconceivably fine. As there was no judging of the Period in regard to Ripeness, at which these now were, it was thought adviseable to spread out a Quantity of the Pulp of the Fruit, about the Place where the Mouldiness appeared, upon a Saucer: The Seeds were spread at a Distance from one another, surrounded with their Pulp, and many of them with the Vegetable also; and the whole was set in a damp Place. We well knew the quick Growth and Propagation of the Plants of this minute Kind, and were sensible what we had to expect from this Preparation. Our Opinions did not deceive us; we found, at the End of four and twenty Hours, a Succession of new Plants of the same Kind with the old, covering the Seeds that had been perfectly free from them when taken out of the Shell, and had thus an Opportunity of examining perfect Plants, instead of injured and decaying ones.

The Microscope for opake Objects, is the proper Apparatus for examining Bodies of this Kind: A single Magnifier is of sufficient Power, and we no Way see Objects so distinct, as thro' only a single Lens. We took up a Seed of the Fruit, covered with the soft Pulp, and the whole Surface, except where it had touched the Thing on which it lay, covered also with the Plant, that was to be the Subject of our Observation: The Forceps of the Apparatus very conveniently held this, and we had an Opportunity of seeing the whole in a very distinct Manner.

It was not a single Plant that overspread the Surface of this whole Seed; there were several distinct Vegetations, each of them ramose, and all of the same Figure and Magnitude. We singled out one of these for the immediate Object of Observation, and, without Difficulty, traced it from its Base to the very Extremities of its several Ramifications.

The Stem is single, and rises, without any Crust for its Base, immediately from the Surface of the pulpy Matter spread over the Seed: It was, in this Place, considerably thick and round. It runs up single a little Way, and then divides into two main Branches; each of these soon after divides into two more, and those again, each into two, in the same Manner. The whole Division is carried on thus in a dichotomous Manner, as in some of the Sea-plants; and the Top Branches, which are very numerous, are extremely minute,

nute, and are not clustered together, but stand remote, and make a very elegant Appearance. The whole Cluster of Plants on one Seed, make an irregular and rude Appearance, but a single one, viewed in this Manner, is an extremely pleasing Sight: It opens regularly into a greater and greater Breadth from the simple Stem or Trunk, to the extremely divided Top, and the Branches spreading every Way equally, the whole Figure is rounded in the Circumference at the Top; and, in general, resembles an inverted Cone.

The Colour of the whole Plant is a Beauty full pearly white, with a Tinge of a clear blue: The Stem is darkest, or has most blue in it, and the Tips or Extremities of the Branches are quite white: The whole is of a tolerably firm Texture, but its Surface appears strangely lax and open, the Cavities being more and greater than the solid Matter which divides them.

It will be easily conceived, that when we had thus taken a general View of the Plant in the whole, by means of a Magnifier, capable to take in all the Furniture of the Seed at once, that is of an Area, sufficient to comprehend twenty or more of the Objects, the adapting one, which should take in but a Part of the single Plant, would give us an Opportunity of viewing that Part much more distinctly. On putting on such a Glass, while the Object remained in the Forceps, we were instantly surpris'd with the View of something very strange in the Surface, but the Quantity of the whole Cluster of the Plants

unluckily obscured the View. We took off a single Plant with a Point of a finer Forceps, and in this, held in a good Light, could distinguish the whole Structure and Compages of the Plant in a very accurate Manner, and the Object was worth all our Attention.

The Base of the Stem, which I had observed to be darker coloured than the rest, was covered with a Multitude of Scales of a cordated Figure, convex at the Back, and sharp-pointed at the Tip, and laid very closely over one another. These covered the Stem up to the first Division: From this Part upwards the Surface appeared of a very different Kind. We could now distinguish that, what we had before seen, was, indeed, far from a continuous Surface, and was not, properly, the Superficies of the Trunk or Stems of the Plant; but its Fruits arranged in a Manner scarce less singular than beautiful. As the Spaces between these Bodies were greater than the Bodies themselves, we could easily see to the real Surface of the Trunks or Branches between them. In a larger Branch, which we first examined, for the whole Plant, from the first Division to the Tips of the extreme Branches, is covered with its Fruit, we could distinguish the Branch itself, in the Form of a Core, surrounded with these Fruits, and forming a Kind of Centre or Axis, from which the Stems or Pedicles that supported them, departed in Form of so many Rays. This Core or Axis was of a cylindric Figure and very irregular Surface: Its Colour white, and its Substance,

stance, to Appearance, tolerably firm: From every Part of this, there stood, in an horizontal Direction, Numbers of slender Pedicles: They all were arranged, in a regular Manner, in Series round it, and each was terminated by a Kind of Button or Head. They were all of the same Length, and resembled very exactly so many minute Pins stuck all round the Stalk by some careful Hand, with the Heads all of a Size, and all at an exactly equal Distance from the Centre.

The Pedicles are fine, beyond Expression; their Colour is a pure white; their Surface smooth and glossy, and they perfectly resemble so many fine Threads of a glutinous Matter, drawn out by touching it, and then gently pulling back the Finger. At the Summit of each stood the Head of a very singular Figure: It was the same in all, without the least Variation: Its Figure, at Sight, appeared round; but, on a closer Examination, each was found to be composed of four Parts, united at their Base, but not so at their upper Extremity; they were there distant, and consequently the whole, when thus strictly examined, appeared not uniformly round, but divided into four distinct Portions. The Colour of these Fruits, for such, or, indeed, more than such they are, for they contain the whole Fructification, was a beautiful pearly bluish White, very exactly that which we see on some white Silk.

On examining the rest of the Plant, we found its Structure throughout exactly the same: The Heads of the Pedicles appeared all the Way of  
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the same general rounded Form, only as the Branches grew smaller, their Pedicles became shorter, and the Bodies themselves less divided, till toward the Tops, there seemed to be no Pedicle at all, nor any Division in the Fruits; but the very Extremities of the Ramifications consisted only of a Series of these round Bodies supporting one another without any Thing to connect them, and resembling the Beads of a Necklace.

Such is the general Appearance and external Figure of this singular and elegant Plant; there could be no Doubt of the Bodies, supported on these Pedicles, being the Fruit; but another Apparatus became necessary to the examining them distinctly. We put together the double Microscope with a large magnifying Power, and shaking the Plants over a fine Plate of Glass, prepared for holding Objects for Examination by that Apparatus, we procured a vast Quantity of these Heads loose from the Plants, some with, and some without, their Pedicles.

This large Power of magnifying shewed us what we had not observed before, that in the Centre of each of these Heads or rounded Bodies, there stood a little Tuft of Filaments between the four Divisions, and not so tall as to reach half Way their Length. In the less ripe Heads, the whole Appearance was round, and a gelatinous Matter covered the Surface; as they ripened, this moist Covering vanished, the Division into the four Parts appeared, and this Tuft  
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of Filaments shewed itself between them: This we discovered, by viewing several of the Heads along the larger and smaller Branches, and viewing them in a more or less ripened State. It was not without some Difficulty, that we found Means of examining this Tuft of Filaments with any Degree of Precision: At length, we found one of the Fruits in a riper Condition than any, and in the Center of this, could very accurately observe the Filaments: They were eight in Number; their Colour yellowish, their Figure pyramidal, and their whole Surface dusty, or covered with a fine Powder. Whoever has observed the Cone of pyramidal Bodies, which is discovered on taking of the Calyptra or membranous Covering from the Heads of any of our common Mosses, has seen an exact Resemblance of these Bodies; only that their Situation is different: In that Case, they stand wide at the Base, and are collected in a Point at the Top, in Form of a Cone; in this, they stand close or nearly so, at their Base, and divide at the Tops.

While we were looking at these, an Incident gave us a very happy Opportunity of seeing their Use and the Manner of Impregnation of the Plant, which is different from all that I have seen in any Vegetable, either of the larger or minuter Kind. In all these, the Antheræ shed their Contents, and the Capsules receive them whole, and never burst till the impregnated Seeds are ready to be discharged. In this, the  
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Capsules open and disclose the Rudiments of the Seeds, in order to their receiving their Impregnation.

While we were busied in examining one of the Clusters of Stamina in the Middle of the Head, we were surpris'd by the bursting open of one of the four Divisions that surrounded it. This appeared at first the Work of Accident; but we soon saw it otherwise: The Opening, by which it had split, was a perfectly regular one, in a longitudinal Direction down the whole Division; and the two Sides had receded violently from one another, and flown back to a great Distance. In this Motion their Edges had necessarily struck against that Side of the Tuft of Filaments which was nearest, and the Concussion had dislodged a Quantity of Powder, which obscured the View for some time. When this Dust had so far subsided, that we could again see with a sufficient Distinctness, we could perceive that the Cavity, discovered by the bursting of the Lobe of the Head, was filled with round and green Seeds; and that these were, in a great Part, covered with a yellow Powder. On examining the Filaments, which had been the Objects of our Attention at the Time this bursting happened, we found they had suffered by the Blow they received in the receding of the separated Parts of the Head; and that the yellow Powder, which was scattered over a Part of the Seeds or Fruits, or by whatever Name it might be proper to express them, was evidently shook off from these Filaments.

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While we were busied in observing this, another Quarter of the Head burst exactly in the same Manner, and with the same Consequences, as the first; and after this the third and fourth, all in the same regular Direction, and all with the same attendant Circumstances.

It was now sufficiently evident, that the Tuft of Filaments in the Centre of the Head supplied the Place of Stamina, supporting Antheræ, filled with an impregnating Powder, or Farinæ; and that, contrary to the Nature of all other known Plants, the Receptacles of the Seeds, or Female Fructifications, burst open, in order to expose their Contents, or the Rudiments of the Seeds or Fruits, to the Reception of the Farinæ. We still were curious to know the Structure of these several Parts; and to this Purpose found it necessary, tho' not very easy, to disunite them. We had a very large Quantity of the Heads upon the Glass, in different States of Maturity; but in all, the several Parts obscured the View of one another. We drew another Plate of Glass gently over the Surface of the first, loaded as it was with these minute Bodies, and succeeded as well as we could have expected. On directing the Eye down again upon the Plane, we found we had torn to Pieces a Multitude of the Heads, and that their several Parts lay open to Investigation.

A separated Cluster of the Filaments first attracted our Attention: These had been loosened from their Place in the Centre of the Head, and

two of them were difunited from the rest, and lay at a Distance from one another. The six that remained together, shewed us very happily the natural Position and Arrangement of them all in the Head: These formed a hollow inverted Cone. The Base of each Filament was thickest, and from this it became gradually thinner, and turned outwards. When we had seen thus much of the Position, the Form remained to be inquired into; and this was much better to be seen in a single Filament, and with a more powerful Apparatus.

On directing the Eye, thus assisted, to one of the loose and single Bodies, we found it of a pyramidal Figure, annulated all the Way up the Surface, thickest at the Base, and very sharp at the Point. The ground Colour we could perceive was a deep Orange Scarlet; but this was rendered paler by certain regular Bodies of a lighter Colour, which were disposed in a regular Manner all over the Surface. It is the Custom of Nature, in general, to lodge the Farina Fæcundans of Vegetables in Capsules, called Antheræ, which are supported on the Summits of certain Filaments, called Stamina, and usually have their Place in the Centre of the Flower. These Filaments, situated in the Centre of the general Head, or, if it be proper to call it so, of the Flower, in this minute and singular Plant, were true and genuine Stamina; and their Office was to support Antheræ, containing the fecundating Powder. But, as in all other Respects, so in this,

## *Natural History and Philo*

this, the Oeconomy of Nature in this Plant differs from what it is in all the other known ones. The pale-coloured Bodies, supported on these Filaments, are true and legitimate Antheræ; but they are not placed singly at the Summit of the Filaments, or Stamina, but in a kind of spiral Line, all the way from the Top to the Bottom of it. The Arrangement is very beautiful: It brings into one's Remembrance the spiral Twirl of some of the Screw-shells; and the pale Straw Colour of the Antheræ upon the deep Scarlet-ground, has a very fine Effect, when viewed distinctly: When seen with a less powerful Apparatus, the whole appears of a bright Yellow.

As the Surface of the whole Stamen or Filament is in this Manner loaded with the Antheræ, the Blow given by the Edges of the separated Capsule of the Female Fructifications cannot but break a great Number of them. Nature contrives that this shall always happen at a Time when the Female Fruits are ready for Impregnation; and the Farina, discharged by the bursting of these Antheræ, naturally falls in Part upon the just disclosed Female Fructifications: And the Provision of Nature is so abundant, that the Portion, which thus makes its Way to the Place of its destined Operation, is fully sufficient to answer the Purposes.

On examining some of the separate and simple Antheræ, we saw them of a globular Figure; and the Apparatus, which we now were using, being

being of sufficient Power for distinguishing the very Figure of the Farina itself, we procured a little of it by shaking and pressing the Plant on a thin Piece of Talc, and found it to consist of regular Globules, of a flatted but spherical Figure.

The Form and Manner of Operation of the Male Part of the Flower, thus understood, it remained to enquire into that of the Female Part. To this Purpose we examined several other Parts of the loaded Plate of Glass, 'till we found one, on which there lay a great Number of loose Lobes or Divisions of the Head; and some, in Part, connected to one another. We found that these, tho' they seemed, on a less accurate View, to be only the several Portions of one and the same Body, were, in Reality, four distinct Capsules, of a Figure approaching to oval, all fixed on the Summit of a slender Pedicle, running from the Axis or Stalk of the Plant; and that the Cluster of Filaments, which were the proper Stamina of the Plant, did not arise from any Part of the Surface of these oval Bodies, but from the Centre of the Summit of the same Pedicle, on the Verge of which they grew. These four oval Bodies were joined to one another at the Base: They were in Contact, but not joined, for about two Thirds of the Way up; and, for the rest, absolutely separate, and at some little Distance from one another.

On examining one of the loose and distinct ones, which had been burst in the natural and regular

regular Manner, we saw that it was, in Reality, no more than a Capsule of a membranaceous Substance, and greyish Colour, serving to inclose a Number of Female Fructifications. These stood in a Cluster, of an oblong and nearly cylindrical Form : They were of a pale green Colour, and very much resembled, in Shape, an Ear of *Indian Corn*. They were a Congeries of oval and somewhat depressed Bodies, arranged all round and every way about the Surface of a thick and regular Axis, but without any Pedicles. The Violence that had been used in separating the Parts of these Fructifications, had dislodged several of these Bodies from the Axis : These lay scattered at a Distance, and shewed their true Figure ; and their Absence from the general Cluster gave us an Opportunity of seeing that they were naturally disposed, but in a single Series, round it : And where they had fallen off, we could distinguish some small Depressions in the Surface of the Axis, into which they had been received.

The Globules of Farina, discharged from the burst Antheræ, were disposed at Random over the Surfaces of many of the separate Seed-vessels, for such these Bodies truly were ; but in what Manner the Impregnation was performed, we could form no Conception, the whole Seed-vessel seeming entire, of an uniform Structure, and impervious on all Parts ; and the Seeds secured not only from Injuries, but, so far as could

be seen, from all Communication with any thing external by it.

Among the intire ones we saw several burst; and it cannot appear a Wonder, that the same Apparatus, which could distinguish the Form of the Globules of Farina, could see the Shape of these: They were of an irregularly oblong Figure, and rough Surface; largest at one End, and a little crooked at the other.

The Propagation of all the minute Plants of this Kind is very quick, and the Raising or Succession of them easy. The keeping up a Succession of this so singular an Object for the Microscope, was much to be desired, and it was as easily attained. We continued the Propagation of it on the whole Inside of the original Pomegranate, and on the Produce of several others, by only spreading the mixed Pulp and Seeds in small Parcels on a Plate about those Seeds which were covered with the flourishing Plants. The Seeds are so light, that they were continually wafted from one of these Spots to the other by the Motion of the Air, and a new Progeny appeared in a new Place every Day or two. I kept up the Succession more than a Month; and was happy in that Time to have an Opportunity of shewing, to most of the People of Abilities and Curiosity this way, what appeared to me to be one of the most singular Products of the Vegetable World.

ESSAY *the Last.*

*On the Nature and Qualities of an Insect inhabiting subterranean Waters.*

I Have had Occasion to observe, in the Course of these Essays, that there is hardly the least Portion of Matter, or the least Drop of a Fluid, of any Kind, naturally found on the Surface of the Earth, that is not inhabited by Multitudes of Animals. The Stores of Nature are more inexhaustible than could be conceived; nor do they stop here: I have had Occasion to find, that even the subterranean Regions are peopled as thickly with their minute Inhabitants; that Waters, whose Current lies at many hundred Feet below the Surface, are as full of Animalcules as those exposed to the invigorating, and as some have supposed it, in regard to these minute Existences, the creative Sun; and that Damps and Cold, and even poisonous Exhalations, have no Power to destroy their tender Forms.

An Account sent me, from the Lead Mines in the West of *Derbyshire*, of a Water which was very troublesome to the Miners, ulcerating their Legs, if obliged to stand in it, and even raising Blisters on the Skin, as it dropt from the Roof; occasioned me to send for some of it to Town, to examine to what such a poisonous Quality could be owing. I totally missed the expected

Discovery; but as the Search after one Thing, in natural Investigations, seldom fails to discover another, I made myself ample Amends for my Disappointment in the Mineral Kingdom, by an unexpected Object of the Animal one.

Whether it were owing to any Mistake in taking up the Water, or to what other Cause I do not pretend to say; but the Fluid afforded nothing, on the Analysis, that could countenance the Opinion of its doing Mischief by coming in Contact with the Skin, or even by being swallowed. It appeared to be common Water, to all Intents and Purposes, unimpregnated with any Particles of the Mineral Kind, and as fit for the Purposes of Life as that which runs in our Rivers. It had been taken up, according to the Account I received with it, at a hundred and fifty Foot depth under the Surface, and there ran in a small Stream through a Part of the Mine, where the Lead Ore was very abundant.

One of the first Trials I made with this was by the Microscope, before any Attempt towards an Analysis by Fire was set on Foot: I was surpris'd, instead of floating Salts, or Spiculæ of any kind of Mineral Matter, to find Millions of Animals alive, and moving about with great Rapidity, and in various Directions. I have had Occasion to observe, that the running Waters in general are not so full of Animalcules as the stagnant: Whether it may be otherwise with the subterranean than with those on the Surface, or whether this Quantity might have been taken  
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from some Hollow, where it had stagnated; or, finally, whether these minute Creatures might not have been produced in it during the Time of the Carriage, (for it had been between three and four Days taken up when I received it) I shall not determine. There now appeared a sufficient Number of them to make me doubt, before any other Trial had been made, the exulcerating Quality of the Fluid; and the future Trials justified the Suspicion.

The Creatures, which were enjoying themselves in a Drop of it, which I had placed under the double Microscope, were not all of the same Size. We very rarely find any of the natural or artificial Fluids of the Surface inhabited by one single Species; and there was all the Reason in the World to suppose, there were of more than one Kind here. The Glasses I had adapted for the enquiring after Mineral Particles, were by no means of sufficient Power for the Investigation of these minute Creatures. I put on an Assemblage of much greater Power, and, under the Assistance of that, could very clearly distinguish what I had suspected, from the imperfect View given by the first Apparatus: All that had appeared in Life and Motion, at that Time, were truly so; nor were the Animalcules, which peopled the Fluid in such Numbers, all of one Kind. There appeared, at first Sight, to be three distinct Species; and something in Motion, tho' almost without any sensible Form, declared a fourth. On adapting still more powerful Magnifiers, I

discerned the minutest as well as the larger moving Atoms were real Animalcules; and began from these to enquire upwards, and, with Combinations of Glasses of still greater and greater Power, into the Forms of the rest.

These minutest Set were, on a close Examination, found to be the same with those of a like Magnitude which people our common standing Waters; and are, in every Drop of Ditch and Pond-water, the Food of a Multitude of others somewhat larger. They were mere inflated Bladders of a spherical Form, with some little Trace of Intestines in the Centre. The next in Size to these were of the common flat Kind, with numerous Series of Legs under the Belly. The third in Magnitude were of the Caterpillar-like oblong Form. All these I had seen, and have described already, as the Inhabitants of other common Fluids, in one Part or other of these Essays. I was afraid, that, notwithstanding all the Promise made by the first Appearance of such numerous Objects of Investigation, all that would be in Reality discovered should be, that these subterranean Waters were peopled with the same Creatures as those on the Surface: But there yet remained one farther Chance in the Favour of a new Insect, and that answered indeed the utmost Expectations.

The Apparatus hitherto used, though twice varied for such as should magnify less, yet took in so small an Area, that it was but by Accident we saw one of the largest kind of Animalcules of  
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this Fluid, and then very imperfectly, and only as it passed in haste under the Glass, but too large to be within its Focus. I adapted a smaller magnifying Power; and taking in a larger Area, with more Light, and a less limited Focus, tho' I lost Sight of one of the minutest Series of the Inhabitants of the Fluid, the two next above it remained in View, though not so much magnified as to be seen with perfect Accuracy. But the largest Kind of all, for the observing which this Apparatus was calculated, was seen very distinctly, and sufficiently magnified, though so large an Area was taken in as gave us an Opportunity to pursue its Motion with the Eye. This was, indeed, a singular and amazing Creature, differing, in the most essential Points, from all the minute Inhabitants of the Sea, or of our fresh Waters, and provided better than almost any of them for catching its Prey. With all this Variety of Apparatus about it, very little however appeared on a first View. We could only distinguish, that something tolerably large, and somewhat opaque, was performing Motions of various Kinds in the Water; but without the least Sight of the Manner in which those Motions were performed, or the Mechanism of Parts that served to the Purpose.

All that we could discover for a long time was, that it was a simple oval Body, of a brownish Colour and polished Surface, somewhat thicker at the Back than on the Belly, and of the Appearance of polished Horn. When we

had been almost tired with the Observation of a Creature, in which there was so little Singularity, under this Appearance we saw one of them stop, and retain itself suspended in the mid Fluid, as a Kite does in the Air. This Position gave us an Opportunity to discover, that the Horn-like Substance we had seen on its Surface was really of the Shell Kind; and that the Creature had a Covering of it, formed of two Valves, each of a semi-oval Figure, and connected at the Back by a Hinge, in the Manner of the Muscles, or Telline Kinds, among the Shell-fish. We soon after discovered, that as in the Pholas, so in this there is a fine, long, and narrow Slip of a shelly Matter, from the upper or larger Part of the oval to the thinner or smaller End, and serving to cover a Fissure left by the inaccurate closing of the Edges of the other two. We had not long perceived this, when we saw it in Motion: I am apt to believe, some Attempts toward this Motion first shewed us that it was a distinct Piece, and not continuous with the rest of the Shell. It was at length turned to one Side, so as to shew the Fissure it had before covered; and from the Base of this Fissure, just at the Hinge of this narrow Valve, that is very near the greater End of the Oval, there was now protruded an oblong fleshy Filament, in all respects resembling the Horn of a Snail: This was of a white Colour, and seemingly of a fleshy Texture, and mucous Surface, quite different from the shelly Covering of the rest. It became  
larger

larger every Minute, 'till at length its Weight and Smallness concurred in making the Point droop; and it continued still increasing more and more in Length, 'till that Point touched the Bottom of the Fluid, or the Surface of the Plate of Glass.

This oblong Body had hitherto appeared a mere simple cylindrick Filament, equal in Thickness all the Way, and truncated at the End: The Extremity, however, now that it touched the Glass, assumed a new Form. It extended to five times its original Diameter, and applied itself all the Way to the Surface of the Plate. It did not in this State assume a perfectly flat Form; but was elevated in the Middle, and seemed a hollow Cone, affixed to the Extremity of the fleshy Filament first seen. While we were admiring the firm Manner in which it seemed connected to the Glass, there appeared all round it a Fringe of floating Hairs: These, after being vibrated some time, were applied in a regular Manner to the Surface of the Glass, they formed so many Rays, parting every Way from a Centre; and when we came to examine them more closely, each was, as it were, bearded all the Way, and furnished with lesser Hairs or Filaments on each Side, turning backwards, and fixed as firmly to the Glass as the original ones, and each of these also hairy.

When these were all fixed to the Glass, we could not but observe in how singular a Manner Nature had provided for the retaining the Creature

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ture in its Place, during its Pleasure; and at the same time giving it, by means of this long Filament, by which that was performed, a Liberty of moving, even in this State; which those that were fastened down immediately, by the Extremity of the Body, could not have. We doubted not but that this was intended to put the Creature in a better Condition for feeding, than it could be in while floating at large in the Water; and we were soon convinced of the Truth of this Opinion. The Manner of its taking its Prey is indeed singular, and varied in the highest Degree.

It was no sooner perfectly fixed than the Filament became yet more and more elongated. Before it began any violent Motion, or shewed any more of its Structure, the Filament was at least of five times the Length of its Body. While we were looking on it, it commenced a very singular Motion: It threw itself circularly about, in a violent Manner; and looked like a Stone, or other solid Body, tied to the End of a String, and whirled round by a Child in Play. We were surpris'd to see the Circle, formed by its Body, altering continually in Diameter; but we soon understood, that this was performed by means of its continually altering the Length of the Filament by which it adhered to the Glass, shortening it gradually to almost nothing at all, while it continued the Motion round and round; and, from this shortened State, extending it again to its full Length, slowly, and by degrees in themselves imperceptible, tho' the Effect of the Whole was sufficiently obvious.

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Whether the Creature took in any Food, during this swift and violent Revolution, it is impossible to say; probably it did not. The Violence of the Whirl put the whole Fluid Scene into a strange Confusion; every Thing in it was drawn toward the Place where it was made, as a Kind of Vortex, and by the gradual Contracting and Enlarging of the Circle, the Body of the Animal was necessarily struck against almost every Thing that came within the Reach of it. The shelly Covering of its Body rendered it incapable of receiving the least Hurt or Contusion from the soft Bodies of the others, with which it was thus brought into a continual Contact; but on the other hand, their tender and gelatinous Forms were undoubtedly wounded, bruised or destroyed by every Blow. When the Revolutions had been performed for about half a Minute, in the Compass of which Time a vast Number of them were made, the Creature began to do it more slowly, and in such a Manner, that every Thing it did might be seen.

The State of the Fluid, now out of its vehement Agitation, gave us an Opportunity of seeing a strange Assemblage of Matters together. It was still in an irregular and undulatory State of Movement, and appeared like the Body of Water in a small Pond, that had been agitated by the shaking and swaying a Boat from Side to Side in it: All appeared a Kind of Chaos or confused Mixture of Things; the Bodies of the two larger Series of Animalcules bruised, wounded,

ed, and either dead or languid, were seen rolling about in a Variety of Directions, incapable of making their Escape, and the Destroyer still continuing, tho' in a faint and careless Manner, its slow Revolution, and feeding on one or other of them as they came in its Way. This was done by opening the shelly Covering at the thinner Edge, as far as necessary, and closing it again upon them in the Instant; so that it was impossible to see by what Means, or in what Manner, it was performed.

It was not long, however, before a new Scene presented itself, and we had an Opportunity of seeing a strange Apparatus in the Creature, and its whole Manner of employing its several Parts in the collecting its Food, when he chose to do that, independently of this rotatory Motion, or properly in Consequence of it. The Fluid began now, as the Motions of the Animal very little disturbed it, to be more and more composed, and the Animalcules of the two lower Series, which had not been quite destroyed, but only bruised by the Blows they received, or possibly only sickened and confused by the Motion given them by the Water, began to move about again, tho' not very swiftly. The Creature now contracted the Filament, by which it was fixed down to the Glass, and drew itself nearer, till at length it came quite close. The Consequence of the Situation of the Filament, which had its Origin from the Back of the Animal, was, that the Belly was now turned upwards.



wards. We saw it instantly open the two Valves or Parts of the Shell, and discover the fleshy Body contained between them. The Valves were thrown back to the greatest Distance that their Hinge would allow, and the Body so perfectly covered them in a few Moments, that, in this Situation, it was not possible to discover there were any such covering Valves. The Form of the fleshy Body of the Creature was now that of a hollow Cone inverted, very wide at the Verge, in Proportion to its Length or Depth. It would not be easy to express it better, than by observing, that it perfectly resembled a common Limpet Shell set on its Top, and viewed from above. The whole was of a pale, bluish grey Colour. In the Centre, there was a Tubercle, which opened tranversely, and was evidently the Mouth; and the Sides or Verge of the Body seemed membranous and very thin, and continually in Motion in a vibratory Manner.

The Creature had not been long in this Position, when we distinguished several oblong and slender Filaments, protruding themselves from different Parts of the Verge, and lengthening more and more till they had encreased to, at least, twice the Diameter of the Body. We, at first, supposed these to be of the Nature of those Fibrils, which had sent themselves off from the Edge of the expanded Extremity of the Filament by which the Creature fixed itself; but we soon found these were of a very different Origin,

gin, as well as Use. On tracing them down to their Insertions, we found these were not at the Verge of the Body, but that they arose from the Sides of the Tubercle, in which the Mouth was situated, and continuing their Course all along the Body, extended themselves a great Way beyond its Verge.

There were twelve of these Arms as they arose from the Tubercle, but each, at a small Distance from its Origin, divided into two; so that there were four and twenty of them, as they were continued from the Verge of the Body. These spread themselves several Ways, and formed a Circle of considerable Extent, every Part of which was wholly in the Reach of one or other of them. The Creature lay, in this expanded Posture, in Expectation of its Food. The lesser Animalcules, of whatever Kind, supplied that, and whatever of them came within the Verge of the Circle was instantly seized by one or other of the Arms. Which ever Division fastened on the Prey, the other all instantly joined it; and they then drew themselves back till within the Verge of the Body; the membranaceous Sides instantly closed upon this, and the Creature exhibited no other Figure than that of a Purse with its Edges drawn together. In this Condition, it remained till it had gorged its Prey, and then expanded itself again, and spread its forked Arms, as at first, in Search of more.

This Species was kept alive with me for more than a Month, and I had the Pleasure of surpris-

surprising many with its Operations. Its Ravages, I found on Experiment, were not confined to any distinct Kinds of the minute Animals. I have, at times, supplied it from the Water of our Ditches and Ponds, and it has been seen to feed as voraciously on those, as on the Natives of its own appropriated Fluid.

Such have been the Discoveries of an Application to the Use of the Microscope for a few Years: Such are the Advantages of directing our Researches, by its Means, to uncommon Objects. If Men of Curiosity, instead of confining themselves to the repeating Experiments and Discoveries of others, would thus launch out into new Sources of this minute Life, they would be continually enabled to entertain both themselves with what, to the Pleasure of the Investigations, would have the additional and eternal Charm of Novelty; and while they entertained themselves, would communicate more and more Knowledge to the World.

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